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MAN'S PLACE IN THE UNIVERSE.

By CAMILLE FLAMMARION.

THE problems which the eminent naturalist, Russel Wallace, has just brought under discussion are certainly among those which may well engage the attention of thinkers, no matter to what school of philosophy they belong. It would take too long to examine them in detail, but we can, in a glance, easily take account of the weakness and fragility of the foundation upon which he seeks to raise his new anthropocentric theory.

The fundamental astronomical thesis of the author may be thus summarized: The number of the stars is not infinite; the entire universe is represented by the agglomeration of stars, of which the Milky Way marks the principal plane; our sun is in the centre of the universe.

We may at once grant that the number of the stars is not infinite. Besides, there are here two contradictory terms. Any *number* whatever cannot be infinite. On the contrary, we can easily imagine to ourselves another star placed here or there, or two stars, or ten, or a hundred. But the infinite is that to which nothing can be added.

But it is of consequence that we should not confound the stars with space. Space cannot be otherwise than infinite. It is boundless, illimitable. If we imagine any confine to it whatever, immediately we pass in thought beyond it. Doubtless we could criticise even the definition of space. Some philosophers, and those by no means minor ones, have defined space as that which separates two bodies in such a manner that without matter there would be no space. On the other hand, theologians refuse to admit the infinity of space, so as not to give to it an attribute of God. They maintain that space is finite, and assert that beyond its limits there is nothing. I venture to think that here there is a mere sophism. If matter did not exist there would still be space, that is to say, a place* in which we might imagine matter to exist.

One of the most curious arguments which Dr. Wallace urges against the "infinite number" of the stars is, that if it were so, there would be stars everywhere over the entire sky, without any empty space, and since that every star is a sun, all these contiguous points of light should form a dazzling sphere, whose brightness should equal that of the sun. This objection to the infinitude of the stars was the subject of long and learned discussions during the course of the 18th century and up to the middle of the 19th. It would not be difficult to settle it to-day.

In the first place there is nothing to prove that the light of the stars does not suffer a diminution greater than the square of the distance, owing to the imperfect transparency of the cosmical medium. Space is not empty. Why may not the ether exercise any absorption on the luminous rays?

In the second place, why think only of the bright stars, of the incandescent suns? And the dead suns? May not as many or more dark stars exist as bright ones? Might not the milliards of dark stars interpose between us and the most distant luminous ones?

In the third place there is nebulous matter. Space is full of it; photography has discovered it everywhere. Why should nebulous matter be necessarily luminous? Originally it may have been obscure.

In the fourth place we may not neglect the cosmical dust to which we owe the Zodiacal Light (a reflection of the solar light), the shooting stars, which the earth encounters by hundreds of milliards in a year, as well as other interstellar phenomena to which it gives rise.

The agglomeration of stars of which our sun forms one is not infinite, it is limited; it is very heterogeneous, as we see it, composed of thousands of clusters of stars of diverse densities, and scattered at diverse distances. The immensity which encompasses it is relatively void, and our sidereal universe is composed of but a determinable number of stars.

It is this stellar agglomeration which Dr. Wallace considers as representing the entire universe, a position which has not been proved. Moreover, in this agglomeration he considers the sun as being central and preponderant. Let us see if it is so.

We are within the Milky Way, since this encloses us under the form of a great circle, but we are neither exactly in its medial plane, nor exactly at its centre. Moreover, the Milky Way is not a uniform and organised sidereal

* Some object that this is tautological. Not so. But we make use of words for speaking and writing. Our conception of space is bound up closely with our sense of touch, our muscular sense. Our ideas are derived from our impressions undoubtedly. But we must not confuse the relative with the absolute unknowable to us in its essence. The exterior world is not conditioned by our sense of it. Without us the Sun, Sirius, and space would exist.

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system of which our sun is a preponderating star. The Milky Way is made up of an agglomeration of clusters of stars disposed pretty nearly in the same fairly wide plane.

The telescope has disclosed a great number of clusters of stars and of nebulæ—about six thousand. But if we place on a chart, representing the two celestial hemispheres, these clusters and nebulæ, a fact is made clear worthy of the greatest attention. It is that most of the clusters are gathered into the plane of the Milky Way, and that most of the gaseous nebulæ are collected, on the contrary, away from this plane, and near the poles of the Milky Way.

This has a significance of great importance to our knowledge of the structure of the sidereal universe.

On the other hand, if we examine the law of distribution of stars in the sky, we ascertain that their numbers gradually increase—for all magnitudes—in proportion as we approach the Galaxy.

But it is of consequence to note that neither for stars nor for stellar clusters is this condensation uniform. It is not, for example, by zones parallel to the Milky Way that we must proceed, for that method is insufficient, but by the direct examination of the sky. If we trace isophotic charts giving the sidereal density as is done on hypsometrical charts for contour relief, these differences are made evident.

On a clear summer night, our eyes, trained astronomically, can observe in this vast celestial girdle of the Galaxy very different stellar densities, and we gain the impression that far from being a regular system, comparable to the solar system, for instance, the Milky Way is a perspective image formed by the superposition of an innumerable multitude of stellar clouds, scattered over immense distances in one chief plane. We see it divided into two unequal branches in Cygnus and the Scorpion, and rent here and there into numberless stars.

Our sun is no more at the centre than his neighbour Alpha Centauri (which lies about forty-one trillions of kilometres from us) or than our other neighbour 61 Cygni (about sixty-nine trillions distant)—both right in the plane of the Milky Way—or than the majority of the stars whose parallaxes have been measured. These stars are distant from us several light-years, whilst the limits of the Galaxy are situated at thousands of light-years.

Not only does our sun not mark the centre of our universe more than our neighbours in space do, but it has no greater weight than they. Alpha Centauri is a splendid binary system and its mass is more than twice the sun's. We do not know what planets may circulate round one or other of these two stars, whose mutual revolution is nearly a century. It is not surprising that we cannot see them, since if our sun were at their distance Jupiter would be a star of the 24th magnitude, separated by 4″ from the sun, which would itself be of but the second rank. Seen from the distance of stars of the 1st magnitude, themselves very diverse, our sun would appear but of the third, fourth, fifth or sixth rank, and might be even invisible from Rigel or Canopus, which have no measurable parallax. The mass of Sirius is equal to that of four suns. Vega is seventy times as bright, and Canopus surpasses the sun in brightness by more than ten thousand times. Dr. Wallace's theory might be excusable for an inhabitant of the systems of Sirius or Capella or Antares, but not for a dweller in our own modest hamlet. If there were a central sun, and if that central sun were ours, the illusion might be granted. But there is nothing of the kind. The solar system is a monarchy with the sun for autocrat. Our sidereal universe is a republic, a federation without a dominating authority.

According to the calculation of Lord Kelvin, the amount of the proper motions of the stars indicates that the number of the suns of our sidereal universe does not seem to exceed one thousand millions. The force of gravitation of these suns, taken in the mean to be similar to our own, would produce the velocities observed of twenty to one hundred kilometres per second. A number ten times greater could only have been deduced if those movements were much more rapid. Granted this milliard of stars, it in no wise proves that it alone exists in the infinite, and that beyond an immense void there may not be a second milliard, nor a third, nor a fourth, nor more. Whatever may be its extension, our Milky Way is but a point in the infinite.

It would even now appear that we know of stars which do not belong to our sidereal system. We might cite with Newcomb, the star 1830, Groombridge, the swiftest of those whose motion has been determined, its speed exceeding 300,000 metres per second. The attractive force of the milliard of stars of which we have just spoken would not appear sufficient (except under special circumstances) to produce such a velocity, and many astronomers think that this star has come from the beyond, and traverses our universe like a projectile. This star is not the only one in such a case.

On the other hand, certain *globular clusters* do not seem to form a part of our agglomeration.

This agglomeration represents a universe. It approximates, in spite of its heterogeneity, to the general form of a flattened spheroid, of which the Milky Way marks the equator. Facts seem to indicate that the forces which influenced its evolution exercised their greatest intensity and activity in its equatorial zone rather than at the circumpolar regions, which have remained backward, less dense in actual stars or in those in the making, colder, and, so to speak, benumbed. Everything is more advanced in the equatorial region than at the poles. Our sun itself appears to be in its summer. There red stars are crowded, and there also are temporary resurrections.

On the whole, then, the astronomical theory of the distinguished naturalist has not been established, and, in fact, is quite inadmissible. It would be superfluous, therefore, to occupy ourselves with its biological consequences relative to our planet, the assumed object of the creation. In our solar system, this little earth has not obtained any special privileges from Nature, and it is strange to wish to confine life within the circle of terrestrial chemistry. Nor is it less so to see a naturalist (whose theories of evolution demand the action of time as the principal factor in the succession of species) forgetting that the epoch in which we now happen to be has no special importance; that the different worlds of our solar family are at different stages of their evolution; and that, for instance, if the Moon is a waif of the past, Jupiter, on the contrary, is a world of the future. The effect of the hypothesis of Dr. Wallace is to narrow our horizon, and to take us back again to the time of Ptolemy, into the prison of a useless firmament. The greatness of modern astronomy, on the contrary, is to burst all barriers, for our science is but a shadow in the face of the reality. Infinity encompasses us on all sides, life asserts itself, universal and eternal, our existence is but a fleeting moment, the vibration of an atom in a ray of the sun, and our planet is but an island floating in the celestial archipelago, to which no thought will ever place any bounds. Never lose sight of the fact that space is infinite, that there is in the void neither height, nor depth, nor right nor left; and in time neither beginning nor end. We must understand that our conceptions are relative to our imperfect and transitory impressions, and that the only reality is the Absolute.

What right have we then to suppose that the limits of our knowledge are the limits of the power of Nature?

Every day we have proofs to the contrary. If we examine into the conditions of life, it would not be difficult to conclude that terrestrial chemistry does not necessarily include the universal vital circle. To limit the work of Nature to the sphere of our knowledge is to reason with singular childishness. Of old, our fathers considered the four elements "earth, air, fire, water" as the principles of all, and saw in them the conditions of life. How many solemn dissertations have been written on this subject? To-day we affirm the necessity of carbon for the constitution of living organisms. But no one knows what carbon is. Our successors will, no doubt, smile at our assertions, and, doubtless, the inhabitants of the systems of Rigel, and of Deneb—stars characterised by the rays of titanium and silicon—would understand nothing of the necessity for carbon.

The careful study of our planet shows that the forces of Nature have LIFE as their supreme end.

Yes, life is universal, and eternal, for time is one of its factors. Yesterday the moon, to-day the earth, to-morrow Jupiter. In space there are both cradles and tombs. The red carbon stars will soon be dead; the hydrogen stars like Vega and Sirius are the stars of the future; Procyon, Capella, Arcturus, are the stars of the present. Aldebaran seems to be already an autumn fruit. Let us open the eyes of our understanding, and let us look beyond ourselves in the infinite expanse at life and intelligence in all its degrees in endless evolution.

THE PALÆONTOLOGICAL CASE FOR EVOLUTION.

By R. LYDEKKER.

(Continued from page 102.)

DISMISSING thus briefly a very interesting portion of our subject, we proceed to bring to the reader's notice some of the most important lines of mammalian descent which have been worked out on palæontological evidence. The most famous and most widely known of these is the horse series, which has been so frequently described in full detail that a very short notice will suffice here. Starting with the little hyracothere of the London Clay—a short-limbed and short-necked ungulate of the approximate size of a fox, with short-crowned cheek-teeth, the socket of the eye completely open, the bones of the lower part of the leg (radius and ulna in front, and tibia and fibula behind) separate, and four front and three hind toes—an almost complete passage can be traced through the extinct three-toed horse-like ungulates of the middle and upper portions of the Tertiary period to the single-toed horses, asses, and zebras of the present day. The modifications include a great increase in bodily size, the lengthening of the crowns of the cheek-teeth coupled with a marked increase in the complexity of their structure, the enclosure of the socket of the eye by a bony ring, the degeneration of the ulna and fibula and the fusion of their upper portions with the radius and tibia respectively, the early loss of the fourth front toe, and the gradual reduction in the size and length of the lateral toes of the tridactyle members of the series, till they are represented in the modern horses only by the so-called splint-bones attached to the sides of the upper half of the cannon-bone of the greatly enlarged middle digit. The five-toed ancestor of the little hyracothere is not yet definitely known, but it was probably not far removed from the phenacodus of the lower Eocene. The similarity between the form of the skull of the little hyracothere and that of the modern horse is most remarkable, and is well shown in a series of models recently added to the collection in the Natural History Museum. So far as human eye can see, the horse has practically reached the supreme stage of evolution, so far as its skeleton is concerned, of which its organisation is capable; the only improvement that suggests itself being the total abolition of the useless splint-bones, which are apt to be a cause of disease. Not the least curious feature in this remarkable series is its repetition in the North American strata; a repetition which has given rise to the suggestion that the modern horses have had a dual origin, one branch developing in the Old World and a second in the New. On the whole, however, it seems more probable that the line of development, which took place when the Eastern and Western hemispheres were much more closely connected by way of Bering Strait than at present, was single. It may be added that the ancestral horses, such as the hyracothere, were closely allied to the lophiodons and palæotheres of the Tertiary, which in their turn lead on towards the tapirs and rhinoceros, so that all the earlier odd-toed ungulates were more or less nearly related.

A most remarkable instance of a line of development parallel to that of the horse series is presented by certain South American Tertiary ungulates belonging to an extinct subordinal group allied to the perissodactyles or existing odd-toed forms. In the most generalised representative (*Theosodon*) of the group in question the feet were three-toed, with the lateral digits functional and of about the same relative size as in the modern tapirs. In the next form, *Proterotherium*, the lateral toes have become much smaller and shorter in proportion to the large central one, and no longer touched the ground in walking. Finally, in *Thoatherium*, according to the Argentine palæontologists, only the single median digit remains in each foot; even the splint-bones having disappeared in the hind-limb, although minute vestiges of their upper extremities persist in the fore-foot. If the restoration be correct, *Thoatherium* was therefore an even more specialised animal in regard to foot-structure than the modern horses. The two lines of evolution presented respectively by the horses and the proterotheres form, perhaps, the most remarkable instance of parallel development with which we are yet acquainted. A somewhat curious, and at present inexplicable, difference in regard to the development of the terminal joints of the toes is, however, noticeable in the two series. In the earlier members of the horse series this segment is comparatively narrow and displays a median cleft, but in the later forms the bone widens and the cleft disappears. Precisely the reverse of this occurs in the proterothere series, the terminal bone of each digit being broad and entire in the earliest form, and narrow and cleft in the latest.

The proterotheres are, however, by no means the only extinct South American ungulates displaying evidence of progressive development. In some of the latest Tertiary deposits of the country—probably belonging to the human period—Darwin discovered certain more or less fragmentary remains of an ungulate with the general proportions and size of the modern camels. Subsequent discoveries showed that the macrauchenia, as it is called, presents the unique peculiarity that the nasal chamber opens in the centre of the forehead, instead of at the extremity of skull. Allied but much smaller animals from the earlier Tertiary strata of Patagonia exhibit a gradual transition from the macrauchenia in regard to the position of the external aperture of the nose-cavity towards the normal mammalian type. And since they likewise show a transition in respect of dental characters, which are very aberrant in macrauchenia, that extraordinary creature is brought into line with less aberrant members of the ungulate order.

In the tapirs and rhinoceroses specialisation has not

been carried to anything like the same degree as in the horse tribe; and has been to a great extent restricted to an increasing complexity in the structure of the cheek-teeth, coupled, in the second of the two groups, with a reduction in the number of the anterior teeth and the development of one or two horns in the middle line of the skull. Nevertheless, in both groups American palæontologists have been able to trace a more or less complete line of descent. The tapirs, for instance, appear to have originated from a small Eocene ungulate known as systemodon, which comes so close to the early ancestors of the horse, that it was at one time included in the same series. Modern rhinoceroses, in which, as we have said, the number of front-teeth is more or less reduced, can likewise be traced back to early Tertiary ancestors without horns, but with a full series of teeth.

Among the even-toed ungulates, or those in which the toes are symmetrically arranged on each side of a line running between the third and fourth of the typical series of five, one of the most complete lines of descent has been traced out in the camel tribe, now represented only by the true camels of the Old World, and the llamas of South America. The evolution of this group seems to have taken place in North America in the middle Tertiary period, in the strata of which we meet with an ancestral form in poëbrotherium—an animal of the size and proportions of a small gazelle, but with all the essential characteristics of a camel, although with a fuller series of teeth, and feet in which the main bones are not fused into a "cannon-bone" and traces of the lateral digits still remain. Earlier members of the group show still more primitive characters, and it is probable, although not quite certain, that these in their turn pass into yet more generalised animals, with four complete toes to the feet, and cheek-teeth in which the crowns are surmounted by simple low cusps instead of forming the tall crescents found in camels and llamas.

Precisely similar differences, both as regards foot-structure and tooth-structure, distinguish the true ruminants (deer, antelopes, etc.) from the pig-like animals. And yet a complete gradation from the former to the ancestors of the latter can be found, although it would perhaps be difficult to construct the actual pedigree. In like manner from the tallest and largest-antlered members of the deer tribe a gradual passage can be traced to the small and hornless dremotherium of the middle Tertiary, from which it is but a step to the still smaller and more primitive gelocus – not improbably the common ancestor of both deer and chevrotains. Giraffes, again, partly with the assistance of that marvellous creature the okapi, are now known to be connected with ruminants of a much more ordinary type.

Till quite recently the elephants and mastodons, forming, with the imperfectly known dinothere, the proboscidea of zoologists, constituted an altogether isolated group whose relationship with other ungulates was quite obscure. The wonderful discoveries of Messrs. Andrews and Beadnell in the lower Tertiary deposits of the Egyptian desert have, however, brought to light the remains of two remarkable animals which, as regards both bodily size and the structure, number and mode of succession of their teeth, serve to connect the modern proboscideans very closely indeed with the more generalised extinct ungulates. Nor is this by any means all, for there appear to be indications of affinity between these primitive Egyptian proboscideans and the ancestors of the modern sea-cows (dugongs and manatis). This is, however, a subject on which little can be said at present, for the evidence is not yet published, and the writer is consequently not at liberty to mention even such facts as he knows. When fuller investigations have been made into African palæontology it is probable that not only will the puzzle of the origin of the proboscidea be completely solved, but their ancestral relation to the sea-cows will likewise become an established fact.

Reverting once more to the carnivora, it will be remembered that the ancestral types of the modern forms are to be found in the extinct creodonts; and it is probable that from the latter a direct line of descent can be traced through various extinct forms to the civets and mongooses of the present day. Till the above-mentioned discovery of mammalian remains in the French phosphorites no carnivora were considered more widely sundered than the civets and mongooses on the one hand and the weasels and their allies on the other; the structure of the hinder part of the base of the skull being very different in the two. Now, however, we are acquainted with quite a number of small mammals from the phosphorites which completely bridge the gap between the groups in question. Since the base of the skull has the same general structure in both, the bears were long regarded as near relatives of the weasel tribe, so that both were classified in a single group, to the exclusion of civets and dogs. Palæontology has, however, revealed the existence of an absolutely complete transition, both as regards dental and foot characters, from dogs to bears. Consequently, not only are we compelled to regard the latter as the descendants of primitive dog-like animals, but the similarity of their skulls to those of the weasel tribe must be looked upon as an instance of parallelism in development and not as an indication of genetic affinity.

Possibly the chain of relationships does not stop even with the affinity of bears to dogs, for the former appear to be intimately related to the sea-bears and sea-lions, although, unfortunately, there is no palæontological evidence at present available to confirm or disprove the presumed relationship.

If there be a real connection between the bear-like land carnivores and the sea-bears, it is almost certain that the typical earless seals must have taken origin from a totally different group of carnivores. And it has been suggested that the typical earless seals may be derived directly from creodonts related to the form described under the name of patriofelis. Since, however, we cannot trace seals further back than the later portion of the Tertiary period, additional palæontological evidence must be awaited before anything definite can be said with regard to their ancestry.

Neither is the ancestry of whales by any means definitely known, although there are some indications of the line of descent of the group represented by the sperm whale and dolphins. The late Sir W. H. Flower was indeed disposed to regard whales as the descendants of early hoofed mammals, but there was no definite evidence in support of his contention, and the probability is that they are related to the early carnivores. In modern whales all the teeth have the same simple conical form, but in the middle Tertiaries occur the shark-toothed dolphins, or squalodons, in which the front teeth differ markedly in character from those of the cheek series, the latter being serrated and implanted by double roots. Still more generalised is the earlier and much larger zeuglodon, in which the cheek-teeth are not unlike those of certain seals. So far as it goes, then, the palæontological evidence tends to connect the modern toothed whales with the carnivora, and it certainly traces their descent from animals departing much less widely from the more ordinary mammalian type. It may be added that certain living porpoises show a few rows of bony tubercles in the neighbourhood of the back-fin, similar tubercles occurring in a more developed condition in some of their extinct relatives. Now with the remains of zeuglodon are frequently discovered a number of bony plates, which there is accordingly strong reason to believe

belonged to that animal. If that be the case, the ancient cetaceans were mail-clad animals, and on that supposition the bony tubercles of the aforesaid porpoises must be the remnants of such a coat of mail. A wonderful instance of inheritance, if only it be true.

Very isolated among living mammals are the anteaters, sloths, and armadillos of Central and South America, collectively constituting the typical representatives of the order Edentata; and until quite recently palæontology gave no clue as to their ancestry. All the living members of the group are characterised by the absence of front teeth (the anteaters, in correlation with the nature of their food, being alone absolutely toothless); and their cheek-teeth are of simple structure, alike in form, and devoid of the hard enamel coating of less aberrant mammals. The Tertiary deposits of Patagonia have, indeed, yielded the remains of an armadillo furnished with a full series of enamel-coated teeth; but this, although a step in the right direction, does not go far in affiliating the group to other mammals. In the lower Tertiaries of North America there have, however, been discovered the remains of a group of extinct mammals—the so-called ganodonts—which there is every reason to believe were the ancestors of the modern edentates. These ganodonts have in some instances a full series of differentiated and enamel-clad teeth, and their skulls and limb-bones show a remarkable resemblance to those extinct South American edentates known as ground-sloths. Moreover, many of the later forms display a tendency to a reduction in the number of the front teeth, and to a partial or complete loss of the enamel of those of the cheek series. On the other hand, the earlier members of the group show evident signs of affinity to the contemporary creodonts and ancestral ungulates. In regard to their resemblances to the typical edentates, Dr. Wortman* writes as follows: "If this astonishing array of similarities is accidental, and does not indicate genetic affinity, then all that can be said is that palæontological evidence is worthless in the determination of the various successive steps in the descent of a group or species. I hold that, in view of all the evidence above set forth, the preposition that the one has descended from the other may now be regarded as a positively demonstrated fact."

As isolated at the present day as the edentates are the rodents, or gnawing mammals, as exemplified by the rat, the porcupine, the hare, &c. In all these animals the single large pair of chisel-like incisor-teeth in the front of each jaw grow throughout life, and thus never develop roots; while they are separated by a long gap (uninterrupted by a tusk, or canine) from the teeth of the cheek series, which never exceed four pairs in each jaw, and are all alike. A further peculiarity of the group is the backward and forward movement of the lower jaw during mastication, as may be seen by watching a tame rabbit feed. Till recently nothing definite has been known with regard to the ancestry of the group; but a short time ago Professor Osborn pointed out that mixodectes and certain other small mammalian types from the lower Eocene strata of North America presented just such characters as might naturally be looked for among ancestral rodents; and he proposed to regard them as forming a primitive section of that group under the name of Proglires. They differ from modern rodents by possessing a full series of rooted incisor and canine teeth, not separated by a well-marked gap from the cheek series, and the absence of a backwards and forwards motion of the lower jaw.

An approximation to the modern rodent type is, however, exhibited among certain members of this extinct group by the tendency to the enlargement of the second pair of incisors in each jaw (corresponding to the single large pair of modern rodents), accompanied by the degeneration of the other two pairs of those teeth and the canines. And from these and other structural features there seems considerable probability that the position assigned to the group by Professor Osborn indicates their real affinities. If so, the modern rodents are closely connected with less aberrant mammals.

Finally, we came to the Primates, which includes two well-defined and sharply distinguished groups, one containing man, apes, and monkeys, and the other the much less highly organized creatures commonly known as lemurs or lemuroids. Widely sundered as are these two subgroups at the present day, there existed in Madagascar, even so late as the human period, a creature which, although evidently a lemur, exhibits certain monkey-characters. When, however, we descend to the basal strata of the Tertiary period—the Lower Eocene—we meet, both in Europe and North America, with a number of small mammals which are certainly referable to the Primates, but exhibit characters tending on the one hand to connect that group with other primitive mammals, and on the other hand apparently to show an intimate relationship between the ancestors of the modern anthropoids (man and monkeys) and lemuroids. With regard to these early forerunners of the highest of all mammals, Professor Osborn observes that three suppositions are possible:—"First, that these Primates represent an ancient and generalised group ancestral to both Lemuroidea and Anthropoidea; second, that they include representatives of both Lemuroidea and Anthropoidea, contemporaneous and intermingled; third, that they belong exclusively to one or the other order." Whichever of these suppositions be nearest to the truth, it is evident that in Eocene times the Primates were represented by a number of exceedingly generalised forms presenting much the same relationship to the modern specialised monkeys and lemurs as the primitive creodonts bear to modern carnivores and the condylarthrous ungulates to existing hoofed mammals. Further, these primitive Primates were themselves not far removed from the ancestral carnivores and ungulates.

In conclusion, as the result of the foregoing extremely sketchy summary, it is quite clear that since the publication of the first edition of the "Origin of Species" palæontological investigations and discoveries have shown that most of the main primary groups of vertebrates on the one hand and of the different orders and families of mammals on the other are respectively connected, as we recede in time, by such a number of intermediate links and gradations that the gaps are now comparatively few and far between. And what is true with regard to mammals is likewise true to a greater or lesser degree in the case of reptiles and fishes.

Gaps, and in some cases large ones, undoubtedly still remain; but in no single instance has any fact been recorded with regard to the past history of vertebrates which militates in the slightest degree against the theory of evolution. On the contrary, everything points to a continuous and orderly succession of forms of life gradually progressing from the primitive and generalised to the modern and specialised types.

The only rational explanation of such a regularly progressive series—especially when the existence of vestigial structures, like the splint-bones of the horse, in certain forms is taken into consideration—that presents itself to the unprejudiced judgment is evolution, and we venture to think that Dr. Wortman is fully justified in his assertion that this may be regarded, from the palæontological aspect alone, as a fully demonstrated fact.

* *Bull. Amer. Museum*, Vol. IX., p. 104 (1897).

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Whether, however, evolution is the result of "natural selection," or any other form of what I take leave to call blind chance, is a totally different question, although one upon which I do not, on the present occasion, intend to enter.

THE ROTATIONS OF THE SUN, JUPITER, AND THE EARTH, AND THEIR EFFECTS.

By Mrs. WALTER MAUNDER.

IN her latest and most valuable work, "Problems in Astrophysics," Miss Clerke says: "The two fundamental problems connected with the nature of the sun are its rotation and its periodicity. They may be quite closely allied, and in regard to both, 'counsels of despair' have begun to prevail. The spot-cycle, like 'Carrington's law,' is set down as a congenital peculiarity, and the mists of the past are invoked to cover the perplexities of the present. . . . Explanatory hypotheses avail little, but the sifting of facts avail much." Elsewhere, when dealing with the "Structure and movements of sunspots," she writes: "Isolated observations are rarely of any considerable value in such complex matters. Meaning accrues to them just in proportion as they can be allied to others made in correspondence with them, but under modified conditions. 'Correlate and compare' should be the watchword of astrophysicists." In the following correlation and comparison I do not wish to suggest any explanatory hypothesis whatsoever. I merely place in juxtaposition observations of some phenomena that appear to be directly or indirectly allied.

Again quoting from Miss Clerke, "Little progress has been made towards ascertaining the cause of solar periodicity. We are only assured that it is not imposed from without, but arises from within; it resembles a 'free' rather than a 'forced vibration.' This conclusion, it is true, tends to relegate the matter to obscurity, for the interior of the sun is a *terra incognita*, and seems likely to remain so. His cyclical changes may belong to his original constitution; they may date from nebular times, and be as inherent as the tone of a bell. Or they may simply characterise a stage of growth, and prove liable to modification and effacement." If the cause of the solar changes is to be sought from the influence of something external—of a planet or of several planets, for instance—then sooner or later, the period, or the intermingled periods, must come unravelled. If the primary cause lies within the solar photosphere, then it may well be that the question is one that our earthly experience may never enable us to answer; to even guess at the true answer. Or the hidden processes may be modified by external influences, so that we may be able to measure the method and extent of these influences, and obtain an imperfect solution of the problem.

In sheer ignorance we are obliged to postulate conduction and convection as the means of conveying heat from the interior of the sun to his photosphere for radiation. The processes of conduction proceed slowly; therefore it is assumed that the sun is "a globe riddled with convection currents of which the shining cloud-shell of the photosphere constitutes the limit." But convection is impeded by viscosity, and this must increase as the temperature and pressure together increase in the lower depths of the sun. There must come a limit where convection currents will cease to flow, and we cannot agree with Miss Clerke that Dr. Wilsing and Prof. Sampson are wrong in limiting "convective circulation within the solar globe to a relatively thin shell of material." In the deeper layers there must be some other methods of transmitting thermal energy. In the "American Journal of Science" for 1902, Prof. Frank Very advocated the theory that under the transcendental conditions of the sun's interior, heat is evolved with explosive energy by the *destruction of matter*. This can, however, scarcely be accepted as a working hypothesis in a science that takes as its basis of argument the conservation of energy and the conservation of matter.

The condition of the sun's interior must prevail also in Jupiter, though in a minor key. Here we have a state of things that bears directly on the question of the solar surface markings, of their periodicity, and of their connection with rotation. In January of the present year, Prof. G. W. Hough published in "Science," N.S., Vol. XVII., No. 420, the results of his study of the planet since 1879, and on this paper I base the facts and figures hereafter given.

It must be remembered that objects are very rarely seen beyond 40° of Jovian latitude. The latitude of 70° is only 1″ from the limb, and hence markings if they exist in such a high latitude are practically invisible to us. Observations of Jupiter's surface are therefore almost entirely confined to the eighty degrees that enclose his equator. Within this region the markings consist of "white" spots, "dark" spots, and belts, all of which are disposed very approximately along parallels of latitude.

Many of these markings have a great degree of permanence. The most famous, the Great Red Spot, has been identified with a great red spot observed by Hooke and Cassini in 1664-6; it was then situated one-third of the semi-diameter of the planet south of the equator in about latitude 19°. It appeared and vanished eight times between the years 1665 and 1708, when it was invisible until the year 1713. It became conspicuous in 1878, since when it has been always visible, though at times so faint as to be lost in small telescopes. This Jovian spot differs from its solar analogues in the degree of its permanence. Like them, it is not stationary in either longitude or latitude, and a further similarity is that its proper motion in longitude is much greater than its proper motion in latitude. It has drifted in longitude about three and one-fourth times around the planet since 1879; its total displacement in latitude has been 1″·7, or about 4000 miles. Its rotation period is not uniformly regular. From observations of Gledhill and Mayer, in 1869 and 1870, its period appeared to be 9h. 55m. 25·8s.; in 1879, Prof. Hough found it 9h. 55m. 33·7s.; in 1898-9, 9h. 55m. 41·7s.; and in 1902, 9h. 55m. 39·7s. Prof. Hough is inclined to connect its visibility with its rotation period.

Prof. Hough differs from most other Jovian observers in concluding that the rotation period of a spot does not depend on its Jovian latitude. He cites the instance of two white spots situated in latitude 6° south, which, from 1879 to 1885, gave a rotation period of 9h. 50m., the equatorial belt giving at the same time a period of 9h. 55m. The period 9h. 50m. is, indeed, more commonly found between the limits −8° and +11°, whereas the longer period is distributed indiscriminately over the surface of the whole planet as far as 38 degrees latitude. The difference of rotation between two near-lying markings he attributes to the difference in their levels. We thus seem to find an analogy to the different rotations given by faculæ and spots, but none to "Carrington's law of zones," —the different rotations given by spots in different latitudes.

Prof. Hough concludes his paper by saying: "It seems to be the opinion of most writers on Jovian phenomena that the planet is yet at a high temperature, but not self-luminous. The high temperature is favourable for the explanation of some of the phenomena observed. . . .

The greater luminosity of the centre of the disk indicates absorption of light, probably due to an extensive atmosphere. . . . I (Prof. Hough) assume that the visible boundary has a density of about one-half that of water. This medium is in the nature of a liquid; in it are located the Great Red Spot and the egg-shaped white spots. In such a medium, all motions in longitude and latitude would be slow and gradual, and the shape and size of the object would have great permanency. . . . The great bay in the south edge of the equatorial belt may be accounted for by assuming that the great red spot is at a lower temperature than the medium in which it floats, and by its lower temperature condensing a portion of the vapour composing the belt. . . . In 1883 I stated that the spot seemed to have a repelling influence on the belt."

If the action of the sun is largely instrumental in causing the phenomena of Jupiter's spots and belts, then any periodicity due to revolution round the sun should recur every twelve years. There is no such cycle conspicuous, and any slight periodicity due to this cause—either in the forms or the rotations of the markings—has escaped notice if it exists. Jupiter has also a fairly large family of his own, but we cannot lay to the account of his satellites the credit of originating his disturbances any more than we can attribute to the planets, the spots, faculæ, and prominences on the sun. But in both cases there may be a modifying influence—a Jovian observer of the very first rank has told me that in his transits of the Great Red Spot during the last years, he has detected a period, corresponding to a conjunction of the two largest satellites—a swing or vibration in the Spot as the satellites pulled on it this way or that.

Here, then, on Jupiter we seem to get some analogy to the sun. The planet is itself at a high temperature, but is scarcely at all self-luminous; its photosphere, if it may be so termed, is of the nature of a liquid; and its maculæ have increased and become more permanent as its radiative output decreased.

In a yet minor degree still, the condition of things prevailing in the sun must also prevail in the interior of the earth. From the solid crust, radiation is *nil*; in the centre the pressure and temperature must be such as have no name.

In the year 1600 Dr. William Gilbert wrote that the "earth is a great magnet"; that its "magnetic virtue" comes from within the earth, and not from the heavens above. This was an inspiration on his part rather than a valid deduction from facts at his disposal, and it was not until the nineteenth century that it was shown that only about five per cent. of the earth's magnetic force is to be referred to electric currents, either circulating round the earth or passing to and fro between the earth and the air. The remainder is derived partly from permanently magnetised substances in the earth's crust, but chiefly from a system of electric currents embedded deep in the interior of the earth and connected with the earth's rotation. The diurnal variations, annual variations (not secular change), and magnetic perturbations are to be ascribed to electric currents in the upper regions; and it is these which vary in intensity with the sunspot cycle. But for the rest there are, I think, three points to be noted. First, in the "Magnetic Declination Tables and Isogonic Charts for 1902," Mr. L. A. Bauer states that, "according to the researches of two Russians, Leyst and Passalskij, the diurnal variation is different over locally disturbed areas, *e.g.*, in regions of iron mines, from what it would be if the disturbances did not exist. . . . . Whether the secular change is likewise different over locally disturbed regions from what it would be if the local disturbance were not present, is not yet known." Next, magnetic storms are most frequent and violent during the periods of sunspot activity, and are in very many instances coincident with the passage of a disturbed region across the central meridian of the sun. During the prevalence of these storms, according to Mr. Bauer, strongly marked variations in the electric currents within the earth's crust manifest themselves along with the variations of the magnetic needle. And, thirdly, it may be a mere coincidence, but it seems a significant one, that the commencement of the prolonged sunspot minimum in the seventeenth century synchronized with the vanishing of the magnetic declination. It would not be wise to press this coincidence too far, seeing that we cannot be certain when the long solar calm really commenced. It was marked and commented upon from 1660 onwards. Neither have we frequent observations of the magnetic declination, nor at many places, and the time at which it disappeared is not the same for all the places of observation. But, taken in conjunction with each other, these three phenomena suggest that the deep-seated magnetism of the earth is not wholly unaffected by the solar changes, and the study of its variation may show evidence of change in the sun.

The chief source of the earth's magnetism is due to a system of electric currents in its interior, and connected in some manner with its rotation. It is believed that the secular change of the earth's magnetism is to be referred primarily to the effect of secondary electric currents generated within the earth by its rotation around an axis not coincident with its magnetic axis. The diurnal variation is taken as due to a system of currents in the earth's upper atmosphere, which are connected with the earth's rotation, in that different parts of its surface are exposed to the action of the sun's rays in a period of twenty-four hours. The variation itself varies in sympathy with several solar phenomena, and is thereby seen to be influenced, directly or indirectly, by the sun's rotation. The solar phenomena which change concurrently with the diurnal variation of the earth's magnetic force are, the corona, the prominences (eruptive and quiescent), faculæ and spots.

The variation of sunspots, both in number, area, and distribution during the progress of the solar cycle, is too well known to need much detailed description. Briefly, at maxima, the spot-zones occupy mean positions in about 15° of N. and S. latitude; as the minima approach, the zones sink and die out near the equator; and about the same time a new series of spot-zones have come into existence in high solar latitudes, and gradually with the advancing cycle approach again the maximum position at about 15° N. and S. There is thus indicated an intimate relation between the intensity of the whole solar disturbance and its distribution in solar latitude. But the individual spots and streams of spots show a closer connection still with the rotation of the sun on his axis. A stream of spots is, or always tends to become, parallel to the sun's equator. Where there is comparatively large initial inclination, the "pull" is so strong that I have noticed a slight swing across the line of latitude before the stream settled down to steady parallelism. So too with a single spot whose umbra was oval, and inclined to the equator.

Spots are rarely seen in higher latitudes than 30°; never I believe above 50°. Faculæ, like spots, wax and wane with the solar cycle, but have two zones of maximum activity in each hemisphere. Their principal maxima are displaced with the spot-zones; secondary maxima occur in high latitudes beyond the regions frequented by spots. They are only distinguishable near the sun's limb, where the greater absorption of photospheric light by the sun's "dusky veil" throws them into bright relief. They are, however, closely connected with, if not actually identical—

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in position at least—with the "calcium faculæ" photographed by Prof. Hale over the solar disc by means of a double slit. The monochromatic photographs show that these "calcium faculæ" lie in a series of belts also along parallels of latitude. I have not heard whether a series of such photographs—first taken by Prof. Hale towards the beginning of the last maximum—have been made in anything like a continuous manner during the decrease of solar activity, and the minimum which has just passed. If so, it would be interesting to know whether these bands move or alter in amount as the solar activity decreases and increases again.

Eruptive prominences are exclusively found in the sun-spot belts. Quiescent prominences have their maximum within 15° of the poles when the sun is most disturbed, and as his activity decreases they move downward and crowd more or less closely round the equator. Since we observe both only when on the sun's limb, we cannot say whether they are disposed in parallel belts or not. The corona seems to follow closely the law of distribution obeyed by the quiescent prominences, but its forms are certainly greatly disturbed and modified by the presence of eruptive prominences. Thus in the corona of 1901, whilst the streamers on the western limb presented the featureless symmetry of dead minimum, the streamers on the eastern limb were moulded and distorted by underlying disturbances, strongly suggesting that the type of corona seen during any eclipse is not due so much to the period reached in the cycle of solar activity as to the actual disturbance of the sun at the very time.

But when the sun is actually quiescent then the undisturbed, we might almost say the normal, form of the corona consists of two pairs of wings folded symmetrically about and parallel to the sun's equator. So that it is evident that the corona, whether or not it partakes of the sun's motion round an axis, is influenced by the sun's rotation; it owes its form to this motion when not disturbed by other—for it more powerful—influences.

There are only three bodies whose rotation effects we can study. The first is the sun, a gaseous body, intensely hot, and intensely luminous, rotating on its axis once in 25 days; we can study the corona, the calcium faculæ and the spots, all influenced in a more or less marked degree by the sun's rotation. We can study the planet Jupiter, a body whose outer shell is probably liquid, still hot, but not luminous to any degree, its spots and belts are distributed in a marked manner along parallels of latitudes; and its rotation is accomplished once in about ten hours. We are on the earth, a body with a solid crust, rotating once in 24 hours, and we can study the systems of electric currents from which the earth's total magnetism chiefly results.

THE CHEMISTRY OF THE STARS.

III.—STARS OF THE SECOND TYPE.

By A. FOWLER, F.R.A.S.

NOTWITHSTANDING the great multitude of lines exhibited by the spectra of stars of the second type, the task of investigating their chemical significance is in some respects easier, and often more certain in its results, than that which has to be faced in dealing with stars of other types. This is because of the very close resemblance between this type of star and the sun, so that whatever may be learned from the spectrum of the sun by making use of more powerful instruments than can be employed in the case of stars, may be confidently assumed to be true of those stars which resemble the sun in so far as their spectra can be compared.

FIG. 7.—Photographic Spectrum of Arcturus, showing chemical origins of some of the principal lines.

[Reproduced by kind permission of Sir Norman Lockyer.]

Of the stars included in the second type, the two chief varieties are typified by Arcturus and Aldebaran; or, adopting the nomenclature of Lockyer, it may be said that the second type comprises the *Arcturian* and *Aldebarian* stars. In both varieties the same lines are present, but in the Arcturian stars the hydrogen lines are relatively stronger than in the Aldebarian, while the reverse is the case with the other lines. On account of the predominance of metallic lines in their spectra, both varieties are conveniently grouped together by Lockyer as "metallic stars." Fig. 7, from a photograph taken at the Solar

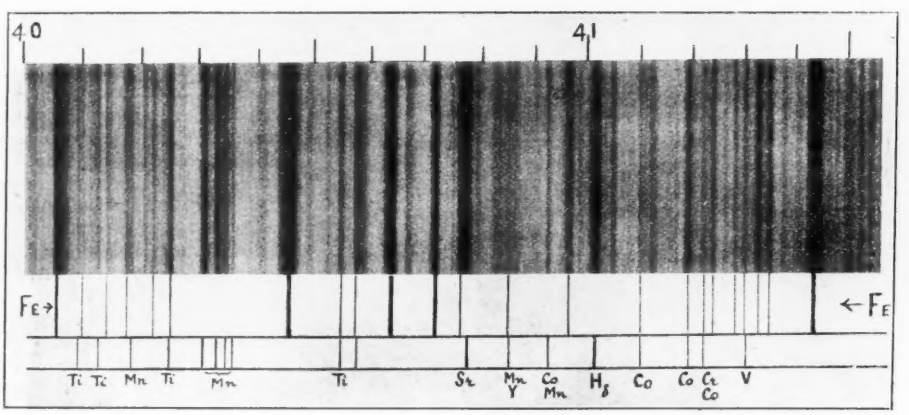

FIG. 8.—A small part of the Spectrum of Arcturus, showing chemical origins of some of the principal lines. (The scale indicates wave-lengths.)

Physics Observatory, South Kensington, gives an excellent idea of the Arcturian type of spectrum, with its numerous well-defined lines. When the spectrum is carefully dissected, it is found that it reproduces the solar spectrum with remarkable fidelity, even in minute details. In Fig. 8 we have an enlarged view of the small part of the spectrum between wave-length 4000 and wave-length 4150, which should be compared with the photographs of the same part of the solar spectrum previously given in Figs. 2 and 3 (KNOWLEDGE, February, 1903). Comparing it with the solar spectrum photographed with moderate dispersion (Fig. 2), the similarity is especially manifest, and the stellar spectrum only differs from the more perfect photograph of the solar spectrum shown in Fig. 3 in compounding groups of close lines into single lines. There is no reason to suppose, however, that such groups would fail to show the separate components if instruments of sufficient dispersion could be employed on the stars.

It is evident then that the sun is the best example of the Arcturian group of stars, and that an interpretation of its spectrum will also hold good for the other stars of the same type. As already explained, this interpretation is based on matching the solar lines with lines of terrestrial substances, preferably by photographic methods, and it is then found that most of the lines correspond in wave-length and relative intensity with those which appear in the *arc* spectra of various metals. The results of such comparisons are best exhibited by tabulation of wave-lengths, and the accompanying brief extract from Rowland's great table of something over twenty thousand solar lines will indicate the nature of the results obtained by the use of instruments of very great dispersion.

(The table should be compared with Figures 2, 3, and 8.)

Wave-length.	Substance.	Intensity.	Wave-length.	Substance.	Intensity.
4043·956	Ti	0	4046·230		2
4044·056	Fe	3	·490		00
·141		2	·612	Cr	0
·294	K	0	·764		000
·423		000	·917		0
·531		00	4047·171		00
·644	Zr	1	·338	K	00
·766	Fe	3	·461	Ce—Fe	2
·992		000	·556		00
4045 108		000	·823	Y	0
·266	Mn	2	·958		0
·371	Ce, Mn	1	4048·224	Cr	1
·538	Co	5	·384		00
·662		0	·549		00
·748	Zr, W?	2	·704		00
·864		0	·818	Zr	1
·975	Fe	30	·910	Mn—Cr	5
4046·117		1	4049·148	Mn	0

It will be observed that many of the lines, chiefly of small intensity (as indicated by the intensity numbers, 0, 00, 000), have not yet been identified, but, as the possible comparisons are by no means exhausted, it is not yet to be concluded that such lines have no terrestrial equivalents. The elements so far recognized as contributing to the solar spectrum in its entirety are as follow:—

Aluminium.	Iron.	Scandium.
Barium.	Lanthanum.	Silicon.
Cadmium.	Magnesium.	Silver.
Calcium.	Manganese.	Sodium.
Carbon.	Molybdenum.	Strontium.
Cerium.	Neodymium.	Titanium.
Cobalt.	Nickel.	Vanadium.
Copper.	Oxygen.	Yttrium.
Chromium.	Palladium.	Zinc.
Hydrogen.	Potassium.	Zirconium.

In addition there is evidence which suggests the possible presence of the following elements:—

Beryllium.	Lead.	Ruthenium.
Didymium.	Lithium.	Tantalum.
Erbium.	Mercury.	Thallium.
Germanium.	Niobium.	Thorium.
Glucinum.	Osmium.	Tin.
Indium.	Platinum.	Tungsten.
Iridium.	Rhodium.	Uranium.

Besides these, though not revealing their presence in the Fraunhofer spectrum of dark lines, helium and the hypothetical "coronium" are important constituents of the solar chromosphere and corona respectively, and there can be little doubt that indications of these gases would also be found in the Arcturian stars if we were near enough to disentangle the spectra of the separate parts of the stars, as we are able to do in the case of the sun. This example forcibly illustrates the important truth that the investigation of such a spectrum as that of an Arcturian star can only directly reveal the chemical composition of the particular part of the star which by its absorption produces the dark lines. The spectrum indicates what is certainly present, but gives no evidence as to what is really absent.

The general result of this analysis of the solar spectrum then is to show that the elements entering into the composition of stars of the second type are not essentially different from those composing the earth, and this obviously is a conclusion of the first importance in considerations relating to the plan of the universe. Its significance can be partially realised when the number and distribution of the stars are investigated. There is already evidence that some thousands of stars have spectra of the second type, but dealing only with those which have been studied in detail, Lockyer finds that out of 470 stars* (including all the stars down to magnitude 3·5 in both hemispheres) there are 78 of the Arcturian and 56 of the Aldebaran group; that is, in more than a quarter of the stars investigated there is direct evidence of the predominance of solar and terrestrial matter. It is indeed not too much to say that not only are the same substances present in all these stars, but that they exist in the same proportions throughout.

A study of the distribution of stars of this type is not less suggestive. Some of the brighter members, according to Lockyer, are as follow:—

ALDEBARIAN STARS.	ARCTURIAN STARS.
γ Andromedæ.	α Aquarii.
γ Aquilæ.	α Arietis.
β Capricorni.	α Aurigæ.
α Hydræ.	α Boötis.
ε Pegasi.	α^1, α^2 Capricorni.
α Phœnicis.	α Cassiopeiæ.
α Serpentis.	α Centauri.
α Tauri.	β Geminorum.
α Toucani.	γ Leonis.
β Ursæ Minoris.	γ Persei.
ε Virginis.	β Virginis.

These few examples will serve to show that the second type stars surround us in every direction, and a further consideration of their distances, so far as they have been ascertained, suffice at least to show the immensity of the space through which terrestrial matter is dispersed. Recently published determinations by Elkin give the parallax of α Tauri as 0″·109, of α Aurigæ as 0″·079, of β Geminorum as 0″·056, and of α Boötis as 0″·026, corresponding respectively to 30, 41, 59, and 125 light-years. Taking proper motion as an indication of stellar distance, the

* "Catalogue of 470 of the Brighter Stars, classified according to their chemistry at the Solar Physics Observatory." (H.M. Stationery Office. 1902.)

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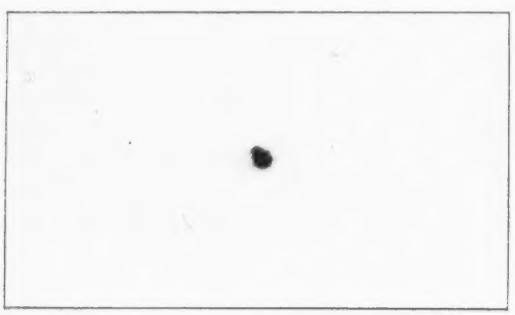
researches of Kapteyn suggest that there is a preponderance of metallic stars among the stars nearest to us, but at the same time there are many stars of this class which have no appreciable proper motion, and are therefore presumably among the stars most remote. It may therefore be concluded that matter similar to that composing the sun is distributed throughout the visible universe.

THE SUNSPOTS OF 1903, MARCH AND APRIL.

By E. WALTER MAUNDER, F.R.A.S.

THE year 1901 was, beyond question, the year of the solar minimum. But the evidences of reviving activity were curiously slow to manifest themselves. There was, indeed, a slight upward progression in 1902, the mean daily spotted area being nearly double what it had been in the previous year. But the intervals during which the solar disk remained absolutely quiescent were numerous and long, so that whereas 81 per cent. of the days in 1901 showed no spots, 72 per cent. in 1902 were in a like case. From 1902, June 5, to September 17, a period of fifteen weeks, there was practically unbroken quiescence; only two or three minute spots—and these faint and short-lived—were seen during the whole time. But with September 18 a more active period began, and the next ten weeks showed more spot groups than the whole of the year beside. December was a quiet month, but new



Group A, 1903, March 26.

spots were seen with the commencement of the new year, and the sun showed a slight but steady activity up to March 21.

On this day a distinctly new phase commenced. A large regular spot, which for distinctness of reference we will call A, appeared on the east limb, in north latitude 24°. Two days later another group appeared, likewise at the east limb and in the same latitude. This second group, B, consisted of a small stream of rather unstable spots. On March 26th a third group, C, appeared also on the east limb. This spot was larger than its predecessors, but was apparently in a later stage of development. The areas covered by these three groups, if expressed in the unit adopted at the Royal Observatory, Greenwich, "millionths of the sun's visible hemisphere," would be about 200, 100, and 260. The Greenwich unit corresponds to a little more than a million square miles, so that the areas expressed as millions of square miles would be approximately 240, 120, and 300.

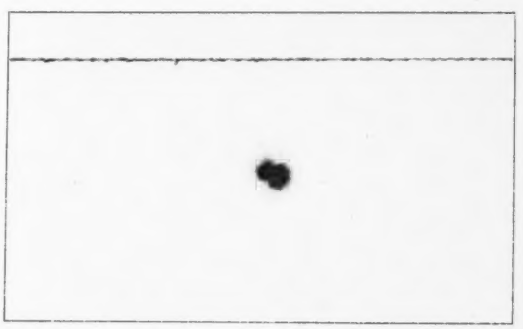
These areas are, of course, quite small compared with those which are presented to us at the time of the solar maximum. Thus on 1893, August 7th, the total area covered by all the spots visible on that day amounted to 6000 millions of square miles; that is to say, an area nine times as great as that presented by the combination of these three groups. Indeed, one of the groups of the minimum year, 1901, was as large as these three groups put together; yet the sun has been so quiet for so long that considerable attention has been attracted by them, not merely in scientific quarters but also in the daily press.

By April 3rd, the first group, A, had passed off at the west limb; the second group, B, which had disappeared for a while and then formed afresh on a somewhat larger

Group C, 1903, March 31.

scale, was approaching the west limb; and the third, C, which was in latitude 17° S., had broken up and greatly diminished, and only two small faint spots remained. As if to compensate for this diminution, a fourth group, D, appeared on this day on the east limb in the same latitude, or nearly so, as group C. Group D was larger than any of its predecessors, and was fairly regular in shape, with a fringe of small spots bordering it on the following side. Its area was about 420 millions of square miles.

A particular interest attached to this group D, in that when it had advanced rather more than halfway towards the central meridian there was a sharply marked little magnetic disturbance, which may or may not have been connected with it. It is certainly not one of the instances



Group D, 1903, April 6.

in which the connection between sunspot and magnetic disturbance is unmistakable, but it deserves note as an instance of *possible* connection.

On April 8th, a small stream of faint spots, E, appeared on the east limb in latitude 22° N. On April 19th, two groups, both small, appeared on the east limb, the one a return of the spot A of March 21st, and the other, F, almost balancing it in the southern hemisphere. That is to say, the two spots had nearly the same longitude, but their latitudes were of opposite signs. Spot C of March 26th returned on April 22nd. On April 24th a new group

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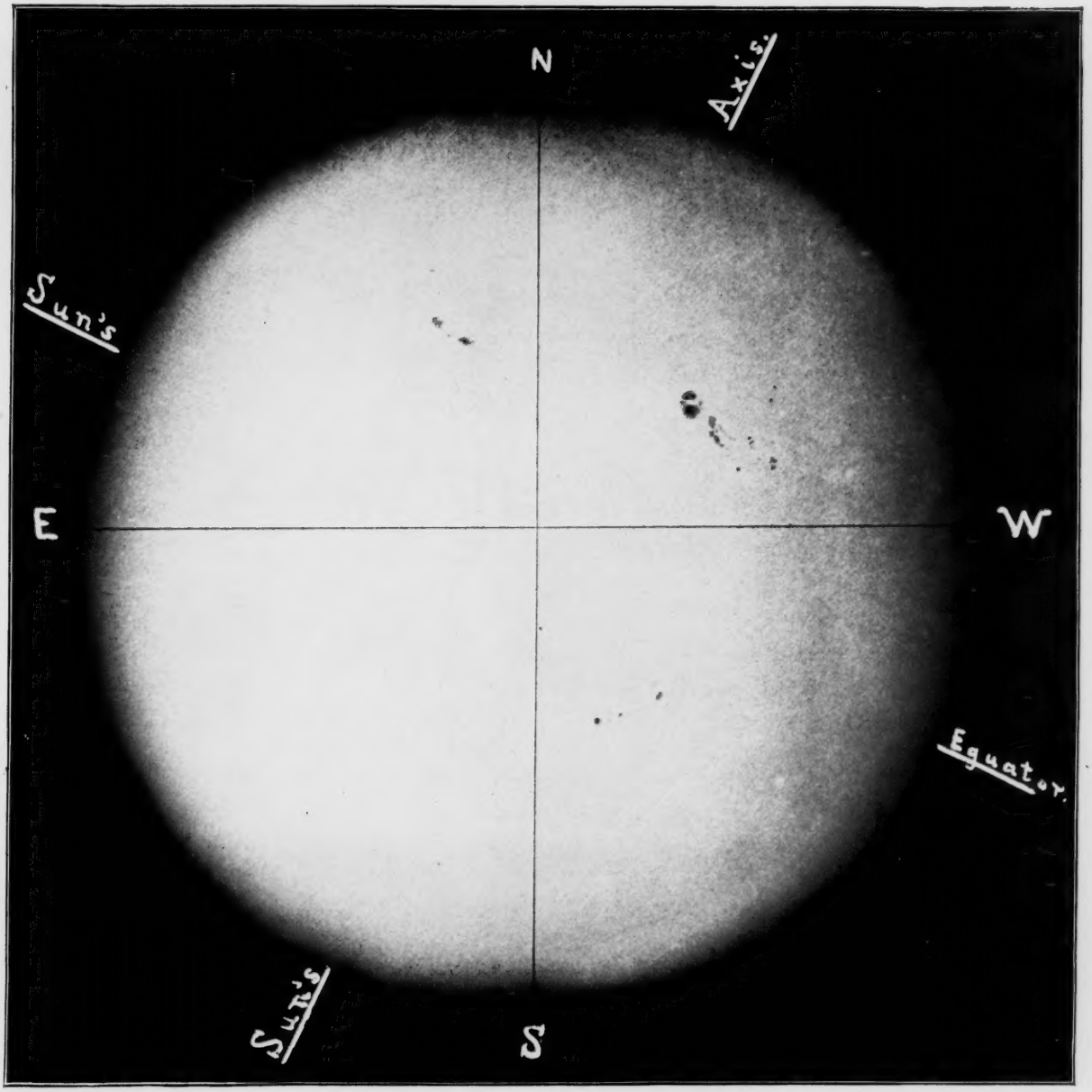

PHOTOGRAPH OF THE SUN;

1903, April 30d. 11h. 11m. 51s., G. Civil Time.

Taken at the Royal Observatory, Greenwich, with the Thompson Photoheliograph of 9 inches aperture.

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appeared at the east limb in latitude 18° N., and was followed three days later by another, H, in the same latitude. On April 30th, when the photograph was taken which forms our plate, and which we owe to the kind permission of the Astronomer Royal, these three groups were all fully displayed near the centre of the disc. The

Group G, 1903, April 30.

two northern groups, G and H, were both streams of sunspots, the larger of which, G,—first seen on the limb on April 24th—now stretched out to a total length of over 100,000 miles. Usually in a stream of sunspots the leading spot is the best defined, and, if not the largest in the group, is only surpassed by the rear spot. If the stream, as is not uncommon, spreads out into two or three branches, inclined to one another at a small angle, they nearly always radiate from the leading spot. In the present instance the reverse is the case.

It is a curious circumstance, well worth attention, that all these eight groups took their rise in the hemisphere remote from the earth. All were first seen as the rotation of the sun brought them into view at the east limb. Group B had, alone of the eight, been seen during an earlier rotation, but like the others it formed in the unseen hemisphere and came into view at the east limb, where it was first seen, a regular spot, on February 23.

Letters.

[The Editors do not hold themselves responsible for the opinions or statements of correspondents.]

MAN'S PLACE IN THE UNIVERSE.

TO THE EDITORS OF KNOWLEDGE.

SIRS,—Dr. Wallace's conclusion is a very old one, almost obsolete. The Earth and man are in his view the centre, the end, and the supreme purpose of the whole universe, and every world and star are in existence for the production and the development of the living soul of man.

This theory, that of all antique religions, has seemed so completely overthrown by the discoveries of science that nobody has dared to defend it. Is the new astronomy coming back after a long digression to the supreme conclusion of the ancient learning? Is the universe a purely anthropocentric thing? We do not believe it, and without following our author to theological ground (we are very incompetent for that) we hope to present some arguments against the views he so firmly advances.

In the first place, from that strictly scientific point of view which is ours, is it correct to say that the Earth is, in the solar system, a planet peculiar in its habitability? To discuss that fully, it would be necessary to expound at length the doctrine of the plurality of inhabited worlds, a doctrine well known by the works of Flammarion, Gore, and many other gifted authors. We prefer to rest on the grounds adopted by Dr. Wallace, and to admit with him that for sustaining life (we ought to say *life such as we know it on earth*) some elementary substances are requisite, and also a temperature restrained between narrow limits during the long sequence of the ages necessary for the evolution of living beings.

According to Dr. Wallace, the conditions of life are:—

1st.—A distance from the Sun sufficient, and just sufficient, to produce clouds, rains, and river-circulation, and to keep up the temperature required. We are of the same opinion, but it seems to us that such a circulation and such a temperature are possible on other planets than the Earth. The spectroscope reveals unmistakable aqueous vapour in the atmospheres of at least Venus and Jupiter. In the general plan of the solar system, the distance from the Sun to the Earth is not peculiar or extraordinary in any way.

2nd.—A sufficient atmosphere to produce the said water-circulation, and to equalise the burning heat of the days and the frozen coldness of the nights. Is this equalisation a property exclusively given to our orb? Are the atmospheres of Venus and Jupiter defective for that office? Dr. Wallace writes also: "The mass of an atmosphere depends largely upon the mass of the planet; Mars is, therefore, unsuitable for life." Is not this in every way a purely gratuitous assumption?

3rd.—A large proportion of the planetary surface covered by oceans, with currents and tides. Tidal action being dependent upon the Moon, the want of such a satellite prevents Venus from having high forms of life. The author forgets that the Sun is able to produce very appreciable tides by itself, especially in the case of Venus, to which it is nearer than to our Earth. And on our Earth, to look at the question from another side, tideless seas (as the Mediterranean Sea) are by no means lifeless.

4th.—The depth of oceans, indicating the permanency of their features. We grant it, but upon what grounds can we assert that such a depth is wanting on other planets?

5th.—The existence of atmospheric dust, produced by deserts and volcanoes, as this is the first cause of rain and clouds. Granted, but volcanoes can exist on other worlds. From this point of view the Moon would be an ideal orb. It is a very curious way of proving that life exists only upon our Earth to say that deserts are peculiar to it. For if there are no deserts on other planets there must be their opposites, viz., a luxuriant vegetation and innumerable forms of life. Anyway, shooting stars and meteorites might supply quite sufficient dust to produce water-condensation.

Such are the arguments by which Mr. Wallace sustains his idea that the conditions of life do not co-exist on other planets than our Earth. We believe very firmly that they are absolutely insufficient for any scientist. We believe, on the contrary, from an impartial study of all the scientific data, that life is possible on other worlds, and that the Earth has not the privilege of being the unique inhabited and inhabitable orb.

We are also unable to accept another view of Dr. Wallace, namely, that on the confines of the universe (supposing it finite) the law of gravitation is not obeyed,

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and radiant energy becomes so irregular that life cannot exist. These are pure assumptions, without any scientific ground to sustain them. On the contrary, we see the law of gravitation ruling over the most distant double star systems. We need more than an assumption to overthrow a doctrine so plausible as that of the plurality of inhabited worlds.

To leave these secondary questions and to examine the problem itself. Dr. Wallace asserts that, on the authority of the new astronomy, the Sun occupies a special and unique situation, being at the very centre of the universe. Do the astronomical results justify that very important conclusion?

The scientific basis upon which Dr. Wallace mainly, if not entirely relies, is that of the invaluable book by Prof. Newcomb, "The Stars: a Study of the Universe." We fear Dr. Wallace did not read this book with sufficient care, for we have just read again that masterly work, and we are by no means led to such a conclusion as that reached by Dr. Wallace.

In the first place we are confronted by the question, "Is the universe finite or infinite?" An insoluble problem in the present state of science. With Newcomb, Dr. Wallace says: "The universe, or, at least, the visible universe seems finite," and he follows the arguments of Prof. Newcomb completely. We believe, personally, that no convincing proof has been brought out against the universe being infinite; but, for brevity, we will grant that the visible universe is a limited body. We will also even grant that our solar system lies in the medial plane of the Milky Way (from the fact that the Galaxy is seen on the Heavens as nearly a great circle, which it would not be if we viewed it from a side of the central plane). But this is all; and we are unable to say with Dr. Wallace that the sun is placed *exactly* at the centre of the Galactic ring. In fact, no such a definite conclusion is warranted except by evidence which is not yet before us.

If we grant, however, that the sun is in the *neighbourhood* of the central plane of the Milky Way, does it follow that we are in the centre of the Galactic universe? It would do so, according to our author; and to put his theory on firm ground, Dr. Wallace again refers to the researches of Prof. Newcomb and Kapteyn (of Gröningen). From their marvellous studies, so clearly set forth by Newcomb in "The Stars," the nearer stars (nearness indicated not by their brilliancy, but by their mean proper motion) would form a sort of solar cluster, almost globular, and the Sun would be deeply immersed in that cluster. But if we suppose these results from somewhat hypothetical stellar statistics to be true, why should Dr. Wallace say our Sun is at the centre of that cluster and, therefore, at the centre of the whole universe?

We have ourselves studied the text of Newcomb's work, certainly the scientific base of Mr. Wallace's paper, and we were quite unable to find any sufficient arguments to establish this central position of our Sun. Prof. Newcomb writes (p. 312) on the nearness of the Sun to the central plane of the Galaxy. According to Dr. Wallace's theory, our luminary must be at the very centre of the Galaxy, otherwise it would lose immediately its unique situation. Even for Prof. Newcomb, it remains to be proved whether the Sun is or is not at the centre of the medial Galactic plane, some facts inducing him to think that we are nearer to one side of the Milky Way (in the constellation Aquila) than to the other. Further, if by hypothesis, at a given instant, the Sun were at the centre of the universe, it would lose its position soon, and never return to it again. We must not forget the proper motion of our luminary, a motion of ten miles per second at least. With that speed, how could the Sun rest for all eternity at the centre of the universe, as a king on his throne? We must not forget also that this solar motion is a relative one, deduced from the apparent opposite motion of the stars. This seems a clear proof that the sidereal universe does not remain concentric (so to speak) with the Sun.

We have, therefore, no right to claim for the Sun, the Earth, and man, a peculiar and privileged position. We must not indeed neglect on *à priori* grounds any theory, however startling and unexpected it may be, but we may respectfully invite the new theorist to submit his views to the cross-examination of science. We regret to say that we believe Dr. Wallace's ideas are not supported by the new astronomy. His paper is astonishing and, in a sense, interesting to read, but we very candidly declare ourselves not convinced by the reasons offered to us, and we remain impenitent adherents of the doctrine of the plurality of worlds; a doctrine so simple, so charming to the human mind, and so fertile in philosophical deductions.

When we gaze on the heavens, we prefer to think that there are other lives and other humanities, than to place ourselves on a pedestal and to look proudly round an empty universe. We acknowledge, without hesitation, that this preference is no material proof of life on other worlds, but we beg in exchange to be allowed, without being considered guilty of contempt for the teachings of science, to regard the Sun and the Earth as very ordinary orbs, having no special characteristics, and as no more suitable for life than innumerable other suns and planets which rotate in the unknown infinite.

MARCEL MOYE,
Professor in the University of Montpellier (France).

5, rue Flaugergues,
Montpellier, France.

IS THE UNIVERSE LIMITED?

TO THE EDITORS OF KNOWLEDGE.

SIRS,—In a notice of Dr. A. R. Wallace's recent article by Professor W. H. Pickering, a view of the question of the limits of the universe is taken which I think will strike many of your readers as new, but seems to be borne out to a considerable extent by the Harvard observations on the stars in the constellation of Orion. It is that an infinite number of luminous stars is quite consistent with the limited quantity of light which we receive from the sky, provided that the distance between the stars becomes (on the average) greater the farther we go from the solar system. On the generally accepted scale, the light of a star of the n^{th} magnitude exceeds that of a star of the $n + 1^{th}$ magnitude in the proportion of 2·512 to 1. Now suppose the average distances of the stars in question to be in the ratio of 1·585 ($= \sqrt{2·512}$) to 1, and that owing to the thinning out of the stars the number only increases in the ratio of 1·256 for each degree of magnitude. The total light of the stars of the $n + 1^{th}$ magnitude would then be only one-half of that of the stars of the n^{th} magnitude; and if the same process went on to infinity, the total light of all the stars fainter than the n^{th} magnitude would only be equal to that of stars of the n^{th} magnitude.

Taking the constellation of Orion, the increase in the number of stars for each magnitude has, according to the Harvard observations, come down to 1·4 or 1·3 to 1 before the stars become too faint for measurement. If this proportion continued to infinity the total light would be of very limited amount. The number of stars would indeed be infinite, for the number of the $n + 1^{th}$ magnitude would always exceed that of the n^{th}, but the total light given would diminish rapidly as n increased, and even if

the process went on to infinity could never exceed a very limited amount. It is, however, essential to this theory (assuming that no light is lost in transmission) that the thinning-out should go on to infinity. If it came to a stop anywhere we should arrive at a different result; and a thinning-out extending to infinity suggests that we are near the centre of the system.

I may add, however, that the constant detection of additional stars by more powerful instruments does not disprove the finiteness (in space) of the visible universe. We may be discovering fainter stars within the same space-limits as those already detected. There are still undiscovered stars (asteroids) within the limits of the solar system, and perhaps our nearest self-luminous neighbour has yet to be detected. Till lately we did not dream of the vicinity of Eros. On this subject (and many others) we must, I think, be content to wait and watch.

W. H. S. MONCK.

[The point is not new. It was put forward very clearly by Mr. Charles E. Inglis in KNOWLEDGE, 1900, March, p. 65. It will be remarked that it assumes the proposition Dr. Wallace seeks to establish of the essentially central position of the solar system.—E. WALTER MAUNDER.]

THE BIBLICAL "MAZZAROTH."

TO THE EDITORS OF KNOWLEDGE.

SIRS,—Can any of your readers tell me what star or constellation the word "Mazzaroth" means in the 38th chapter of Job and 32nd verse?

JAMES B. BOWER.

Claremont, Teignmouth, Devon.
24th March, 1903.

[There is an evident parallelism between Job IX. 9 and Job XXXVIII. 32; and the "Mazzaroth" of the latter answers to "the chambers of the south" of the former. These are without doubt the twelve signs of the zodiac through which the sun passes in the course of the year. Each is brought out in its own "season," whilst the circumpolar constellation of the "Bear" (*see* the Revised Version) is always above the horizon, but is "guided" with her train in her unceasing circuit round the pole.—E. WALTER MAUNDER.]

Notes.

ASTRONOMICAL.—The interesting problem presented by the feeble nebulosity surrounding Nova Persei has been attacked in a most courageous manner by Mr. Perrine, of the Lick Observatory (Circular, No. 33). On account of its exceeding faintness, any attempt to determine the spectrum of this nebulosity seemed almost hopeless, but in view of the great importance of such knowledge, a photographic spectroscope of small dispersion was specially constructed for the purpose in connection with the Crossley reflector. Commencing with 7h. 40m. on the night of October 31st, 1902, and ending with 9h. 25m. on November 4th, a photographic plate was exposed to the spectrum of "condensation D," for no less than 34h. 9m., and it must have been very gratifying to find that the resulting negative showed even a very faint spectrum. A careful discussion of this photograph has led to the conclusion that the spectrum of the nebulosity in November, 1902, was not the spectrum of an ordinary gaseous nebula; that it was not the spectrum of the Nova since the latter became nebular; and that it more nearly resembled the spectrum of the Nova during the first few days of its outburst. This spectroscopic evidence is considered to be not inconsistent with the theory that the luminosity of the nebula is due to reflection of the light emitted by the Nova at the time of its greatest brightness, but it is not regarded as in itself quite sufficient to establish this theory.

Great activity on the part of the staff of the Lick Observatory is indicated by other circulars recently published. No. 29 gives particulars of measures of 117 new double stars, more than half of which have distances not exceeding one second. No. 30 gives observations, elements, and ephemeris of Comet a 1903 (Giacobini). No. 31 announces the variable velocity in the line of sight of ν Andromedæ, π^4 Orionis, σ Geminorum, and ι Argus; it is also noted that ϕ^2 Orionis has the great radial velocity of nearly 100 kilometres per second.

It has long been understood that spectroscopic determinations of the velocities of the components of a binary star, taken in conjunction with ordinary telescopic determinations of the orbit, would lead to a very exact knowledge of the parallax of such a system. This method of arriving at the parallax of a star has recently been successfully applied at the Lick Observatory to Delta Equulei (Circular 32), in which case the period is only 5·7 years, and the motion therefore relatively rapid. At the last periastron passage, about the middle of 1902, the relative velocity of the two components in the line of sight was found to be 20·5 miles per second, and the resulting value of the parallax is 0″·071. From this it results that the total mass is 1·89 times the sun's mass, and as the magnitudes are slightly unequal, the mass of the brighter star probably does not differ much from that of the sun. At periastron the distance of the components is about two astronomical units, and at apastron five of these units, the orbit being very eccentric. It is interesting to note further that, broadly speaking, the spectra of the stars are of the solar type.

It is interesting to learn that Nova Geminorum would not have escaped record even if it had not been discovered by Prof. Turner during its brighter stages. The nearly continuous photographs of the heavens made at the Harvard College Observatory indicate that while there was no star as bright as 9th magnitude in the position of the Nova on March 3rd, the Nova was about mag. 5 on March 6th, after which the brightness diminished. On a photograph taken on March 25th, the spectrum of the star is very conspicuous, showing several bright lines, which at once distinguish it from ordinary stars. By the end of March, transition to the nebular spectrum had already commenced.—A. F.

BOTANICAL.—The remarkable *Davidia* which, until recently, has been known in Europe only from dried specimens, seems likely in the future to become a familiar plant in this country. It is a native of Central China, whither a collector was sent a few years ago by Messrs. Veitch, of London, for the special purpose of procuring its seeds. He has succeeded in this, and has brought home some additional information as to the peculiarities and distribution of the tree. The *Davidia* is a monotypic and somewhat anomalous genus of Cornaceæ. It reaches a height of thirty feet, and is not unlike our common lime tree in foliage. Its flowers are unattractive, but a striking effect is produced by the presence of a pair of very large white bracts just below every flower or flower-head. The mode of germination of the seeds is noteworthy. The fruits are ellipsoid, about an inch and a quarter long, the outer layer pulpy and the endocarp bony and grooved. It is indehiscent, but after lying several months in the

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ground some pieces of the endocarp between the more prominent ridges fall out like miniature shutters, leaving as many apertures as there are cells and seeds in the fruit, and through these the radicle easily escapes. The tips of the cotyledons remain in the cavities of the fruit till the radicle has fixed itself to the soil, when they are completely withdrawn.

Monsieur Drake del Castillo has a paper in a recent number of the *Bulletin du Muséum d'Histoire Naturelle* (Paris) on the curious Didiereas, a genus of spiny trees from Southern Madagascar, which has hitherto not been satisfactorily assigned to any existing natural order. The late Dr. H. Baillon, who established the genus, placed it among the Sapindaceæ. Dr. Radlkofer, an eminent authority on this family, did not concur with Baillon, but thought that *Didierea* should constitute an independent order allied to Polygonaceæ and Amarantaceæ. It approaches the former in its fruit, pollen, and other characters, and recalls the latter in the structure of the embryo, and in having the anthers deeply cleft at the two extremities. It is pointed out, however, that *Didierea* has an anatropous ovule, whereas in Polygonaceæ it is orthotropous. Monsieur Drake del Castillo has made it the type of a new natural order, which he has called Didiereaceæ, admitting, also, another genus, *Alluaudia*, which is likewise a spiny tree from Madagascar.—S. A. S.

ZOOLOGICAL.—According to a very interesting and well illustrated article in the April number of the *National Geographic Magazine* (New York), by Mr. G. H. Grosvenor, the introduction of domesticated reindeer from Siberia into Alaska has turned out a thorough success. The Eskimo have proved themselves well-fitted to keep and train the animals; and it is hoped that in the near future the country will have large herds of these valuable ruminants. This will prevent the Eskimo becoming a burden to the revenues of the United States, as would otherwise have inevitably been the case owing to the diminution in the numbers of the whales, seals, walruses, bears, &c., which formerly constituted their means of subsistence. Mr. Grosvenor graphically describes the difficulties experienced in getting the Chukchis of Eastern Siberia to part with their cherished reindeer.

Naturalists will be greatly interested in a paper recently read by R. J. Pocock before the Zoological Society of London on the geographical distribution of the "trapdoor" and bird-eating spiders, in which it is pointed out that the zoological regions into which the world may be mapped out from the evidence of this group are practically identical with those indicated by mammals and birds. The importance of this can scarcely be over-estimated. We are glad to see that the author discards the terms "Palæarctic" and "Nearctic" in favour of "Holarctic," which embraces the northern portion of both hemispheres, and that he also recognizes a "Mediterranean" and a "Sonoran" region. His scheme differs, however, from some of those recently proposed by the absence of a "Malagasy" region; and now that the lemurs of Madagascar have been shown to be more closely allied to monkeys than was formerly supposed to be the case, perhaps the arguments for the separation of this island as a distinct region may be reconsidered.

The death of Monsieur P. du Chaillu recalls the great controversy which raged in the early sixties over the "gorilla question." If that great and energetic explorer had but been content with the honour of being the first to bring complete skins of the great West African ape to Europe, all would have been well. He was the discoverer of that most remarkable mammal the *Potamogale*, and also brought home the first skins of that lovely antelope the bongo, which was not, however, as he supposed, an altogether unknown species at the time.

It would be difficult to overrate the importance of Dr. C. W. Andrews' paper on the evolution of the Proboscidea, an abstract of which appears in a recent issue of the *Proceedings* of the Royal Society. Till the discoveries of Messrs. Andrews and Beadnell in the Eocene strata of the Fayum district of Egypt, the birthplace and origin of the Proboscidea were unknown. Both are now ascertained. Nor is this all, for Dr. Andrews is able to point out the mode of evolution of the trunk of the mastodons and elephants. In the ancestors of the group the lower jaw was short and stout with a short symphysis. As the animals increased in stature the lower jaw lengthened, this being mainly accomplished by the prolongation of the symphysis. In correlation with this a short trunk, formed by the upper lips and nose, was developed. Gradually the trunk increased in length, while the symphysis of the lower jaw shortened, till the evolution culminated in the long trunk and short lower jaw of the modern elephant. *Pari passu* with this were changes and modifications in the dentition, for the details of which our readers must refer to the original memoir.

A question as to the preoccupation and orthography of zoological names is incidentally raised by Dr. Trouessart in the April number of the *Annals and Magazine of Natural History* when describing the West Indian musk-rat. For this rodent the Doctor had previously proposed the name *Megalomys*, but as he finds this preoccupied by *Megamys*, the new title of *Moschomys* is suggested. In this course we believe the author to be fully justified. Many naturalists of the present day—especially Americans—will not, however, admit this, urging that if a name be ungrammatically formed or misspelt, it is entitled to stand as distinct from the orthodox name. The question urgently requires settlement by an influential body of naturalists so as to ensure uniformity of practice.

We are delighted to associate ourselves with the congratulations to our distinguished contributor, Miss Agnes M. Clerke, upon her election as Honorary Fellow of the Royal Astronomical Society, an honour in which she is associated with Lady Huggins, the wife of the President of the Royal Society.

British Ornithological Notes.

Conducted by HARRY F. WITHERBY, F.Z.S., M.B.O.U.

Gulls as Grain Eaters.—On April 25th, on the small island called the Calf, that lies just to the south of the Isle of Man, I noticed a great number of small piles of what looked like chaff dotted here and there about the rocks. On inspection these turned out to consist of the shredded outside of grains of oats, the grain itself being represented, as a rule, only by small fragments. In some cases, however, the grains were there intact. In one instance there was a small pile of *débris*, half oats, half fish bones. There is no doubt that the Herring Gulls which were there in scores had been regaling heartily on the oats recently sown in the Isle of Man, and had ejected, on returning to their nesting places, what they found indigestible. Sometimes the "chaff" would be immersed in a fluid secretion, having just been brought up by the Gulls circling above. We have here a phenomenon similar to the ejection of pellets by Owls and Hawks, the only difference being that the indigestible shreds were floating in a fluid instead of being formed into a compact mass.—F. W. HEADLEY, Haileybury.

Mortality among Cormorants, Shags, and Gulls during their First Winter.—I noticed both near Scilly and at the Isle of Man during last April what is certainly worthy of remark, viz., the very small number of young Cormorants and Shags (*i.e.*, last year's birds) compared with the mature birds. The young Cormorant is easily distinguishable by his dirty-white breast, and the young Shag by his brownish plumage,

very different from the glossy green of the adult bird. The small number of immature birds points to an enormous death rate among birds of these species in their first winter. Among Gulls the same phenomenon is, I believe, indisputable. At the breeding places in spring there are mature birds in huge flocks, far outnumbering the young birds which are to be seen, *e.g.*, in harbours.—F. W. HEADLEY, Haileybury.

Hoopoe in Hampshire.—On April 25th last, while taking a walk in the New Forest, Mr. A. D. Sapsworth and myself had the pleasure of watching a Hoopoe. I have not seen the bird since, and fear that it has met with the same fate as most of the Hoopoes which visit our southern counties annually. On the same morning, I may mention, in a walk of some three hours we identified 49 species of birds.

The Arrival of Summer Migrants for 1903.—The following table of arrivals of summer visitors, compiled from various sources, may be of interest. The dates for first arrivals seem generally about the same as other years for the southern counties, but the inclement weather at the end of March and the beginning of April seems to have checked, probably in southern Europe, further migration, and to have stopped the birds from spreading northwards in England:—

Sand-Martin	March 23	Ireland, Wales, and West of England.
House-Martin	March 22	Wiltshire and Gloucestershire.
	March 27	Norfolk.
Swallow	March 21	Hampshire, Gloucestershire, and Ireland.
Chiffchaff	March 12	Berkshire.
	March 16	Oxford.
	March 24	Southern and western counties.
Wheatear	March 18	Hampshire.
	March 24	Southern and western counties.
Redstart	March 21	Hampshire.
	April 21	Wales.
Whinchat	March 20	Shropshire.
Blackcap	April 5	Devonshire.
Yellow Wagtail	March 23	Nottinghamshire.
	April 8	Gloucestershire.
Nightingale	March 31	Essex.
	April 7	Wiltshire.
	April 10	Hampshire.
	April 12	Suffolk.
Cuckoo	April 10	Kent.
	April 18	Essex.
	April 20	Hampshire.
Tree Pipit	April 17	Surrey and Staffordshire.
	April 20	Wales.
Grasshopper Warbler	April 21	Wales.
Lesser Whitethroat	April 22	Wales.
	April 29	Hampshire.
Swift	May 5	Hampshire.
Wryneck	April 6	Hampshire.
	April 12	Kent.
Willow Wren	April 19	Hampshire.
	April 26	Kent.

Early Nesting of Birds in 1903.—The following records of a few early nests may be of interest. The Nightingale's nest is extraordinary, but I have it on good authority.

Nightingale	April 18	3 eggs	Surrey (A. D. Sapsworth)
Song Thrush	March 6	Fledged young	Kent (J. F. Green)
	Feb. 26	Eggs	Kent (J. F. Green)
Robin	March 7	Eggs	Kent (J. F. Green)
Dartford Warbler	April 26	Feathered young in nest	Hampshire (H. F. W.)

Combative Green Woodpeckers.—One often sees in the early spring two male Green Woodpeckers engaged in a sort of mock combat over a female. In the *Field* for April 18th (p. 654), however, a deadly duel, which was witnessed by "J. E. S.," is described. He saw two birds fighting in the middle of a path. On his approaching, one of the birds (a Green Woodpecker) flew away, while the other bird "lay struggling on the path, severely injured, blood flowing copiously from its neck, and in a few moments it died." The dead bird was a male, and its neck was fearfully lacerated, while its tail and other feathers were pulled out.

All contributions to the column, either in the way of notes or photographs, should be forwarded to HARRY F. WITHERBY, *at the Office of* KNOWLEDGE, 326, *High Holborn, London.*

Notices of Books.

"SPIRALS IN NATURE AND ART." By T. A. Cook, with a Preface by Prof. E. Ray Lankester, F.R.S. Pp. xxi. and 200. (Murray.) Illustrated. 7s. 6d. net.—At Blois there is a staircase of peculiar form which there is reason to believe was constructed between 1515 and 1520 by a friend of François I. The name of the architect has hitherto been unknown, but Mr. Cook gives good reason for believing that the only man who could have designed the staircase was "Leonardo da Vinci, that great Italian artist, mathematician, scientist and engineer, who died in exile within a few miles of this very staircase a year or two after it had been begun." The spiral of the staircase appears to be the same as that seen in a section of the rare form of the shell *Voluta vespertilio*, in which the helix follows a left-handed instead of the ordinary right-handed curve. Leonardo would certainly have known of this natural spiral; moreover, he was left-handed, and ninety per cent. of the screws and spirals contained in his manuscripts are left-handed spirals. These and other facts go to establish Mr. Cook's thesis, and whatever may be the ultimate judgment upon the evidence brought forward, there is no doubt that he has produced a most interesting book which should direct attention to the work of one of the greatest intellects which the world has seen. It is perhaps worth remark that botanists regard the direction in which twining plants climb from above and not from below. The hop and honeysuckle thus climb in right-handed spirals, and the convolvulus in a left-handed fashion, but Mr. Cook, though familiar with these habits, refers to the two former plants as twining to the left, and the latter as exhibiting a right-handed direction. There are two ways of looking at most things, and this is very true in connection with directions of spirals.

"PAPERS ON MECHANICAL AND PHYSICAL SUBJECTS." Vol. III. "THE SUB-MECHANICS OF THE UNIVERSE." By Prof. Osborne Reynolds, F.R.S. Pp. xvii. and 251. (Cambridge: University Press.)—An outline of Prof. Reynolds' new theory of the universe was given by him in his Rede Lecture, already noticed in these columns. The present volume contains the detailed mathematical analysis by which the ability of the theory to account for fundamental physical properties is demonstrated. The paper which makes up the volume was read before the Royal Society in February, 1902, and has been accepted by the scientific world as a contribution of great significance. For many years, the ether—a non-atomic continuous medium pervading the universe—has been called into being to explain action at a distance. Prof. Reynolds revolutionises this idea, and substitutes for the ether a granular medium having dimensions and properties which he shows are sufficient to satisfy the demands made upon physical theory. In his words this mechanical system "is neither more nor less than an arrangement, of indefinite extent, of uniform spherical grains generally in normal piling so close that the grains cannot change their neighbours, although continually in relative motion with each other; the grains being of changeless shape and size; thus constituting, to a first approximation, an elastic medium with six axes of elasticity symmetrically placed." Such an arrangement as this possesses very remarkable properties, and the dilatation which follows from strains caused by local inequalities in the density of the medium completely accounts for potential energy, the propagation of transverse waves of light, gravitation, and related facts. Prof. Reynolds has developed a theory which will make men of science associate his name with those of Newton and Maxwell. He has long been recognised as a versatile genius, and his latest contribution to science can justly be described as epoch-making.

"COMETS AND THEIR TAILS AND THE GEGENSCHEIN LIGHT." By Frederick G. Shaw, F.G.S., &c. (Baillière, Tindall & Cox. 1903.) 2s. 6d.—This nicely printed little volume, illustrated with several views of Donati's comet and its orbital positions when near the sun, contains an attempt to explain comets' tails by the passage of the solar rays "through the gaseous atmosphere surrounding the nucleus of a comet, and thus rendered more vigorous and more capable of being reflected from the meteoric bodies, dust, etc., existing or moving through space or from the sun's atmosphere, if such a matter exists, in the vicinity of the comet." This practically constitutes a revival of the old view held by Tycho Brahé and others. The author does not appear to have made out a strong case. The peculiar forms displayed

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by certain comets, the immense extent and curvature of some of their tails, and other facts appear to be decidedly opposed to Mr. Shaw's conclusions. Undoubtedly there are shoals of meteoric bodies circulating in planetary space, and it is probable that they are crowded in circumsolar regions, but it is very hard to believe that they could be rendered so strikingly visible over vast regions by the simple effects of refraction exercised by the heads of comets. It seems much more plausible to believe that the tail is born in a comet, and due to the emission of luminous material from the nucleus under solar action. On page 6 the author says, "the tail of a comet is invariably pointed—if one may use that expression—in the opposite direction to the sun," but this is not always accordant with observation. In certain cases comets have displayed two tails (those of 1823 and 1851 furnished examples), one of which was directed *towards* the sun. Mr. Shaw also alludes to the Gegenschein in his book, and attributes this appearance to the action of our atmosphere in "focussing the refracted rays of sunlight passing through it." It seems more probable, however, that the phenomenon is due to the reflected light of an assemblage of meteorites in the region opposite to the sun. We have noticed several errors in the book, thus, on page 15 we read, "the comet of 1774 is recorded to have had six tails." We suppose the comet of 1744 is referred to here. On page 27, Donati's comet is stated to have been "discovered by H. P. Tuttle on June 2, 1858."!

"THE BURLINGTON MAGAZINE." Edited by Robert Dell. (The Savile Publishing Co.) 2s. 6d.—Whatever of reproach that has hitherto attached to England for the lack of a really artistic art magazine, can no longer remain an imputation upon our seriousness in art after the appearance of the *Burlington Magazine*, and for this reason alone we wish it success. But it has stronger claims to our support. Luxurious in margin, its text is enshrined in a large clear type, while it is actually printed on paper, paper that is, if we mistake not, quite innocent alike of the grass crop or the timber yard. As is fitting in such a work, it is in all respects a triumph of the typographic arts, while it excels in the finer and more difficult task of pictorial reproduction. Quite lavishly illustrated, but never cheaply, we have nothing but praise to bestow upon the many beautiful plates to be found in the work. The editor has written an admirable editorial article descriptive of the project, with the sentiment of which we entirely concur, and in all earnestness we offer our new contemporary a right royal welcome.

A selection of Mr. Lydekker's zoological and other articles from KNOWLEDGE is about to be re-issued by Messrs. Hutchinson under the title of "Mostly Mammals."

BOOKS RECEIVED.

The Stellar Heavens. By J. Ellard Gore, F.R.A.S. (Chatto & Windus.)

The Sciences. By Edward S. Holden. (Ginn.) 2s. 6d.

Plane and Spherical Trigonometry. By G. A. Wentworth. (Ginn & Co.) 4s.

Elementary Ophthalmic Optics. By Freeland Fergus, M.D., F.R.S.E. (Blackie.) 3s 6d. net.

Electrical Engineering Measuring Instruments. By G. D. Aspinall Parr, M INST.E.E., A.M.I.MECH.E. (Blackie.) Illustrated. 9s. net.

Practical Plane and Solid Geometry. By Joseph Harrison, M.I M.E. (Macmillan.) 2s. 6d.

Climatology. By Dr. Julius Hann. (Macmillan.) 12s. 6d. net.

Geometrical Optics. By Thomas H. Blakesley, M.A. (Whittaker.) 2s. 6d net.

Electrical Installations. By Rankin Kennedy, C.E. (Caxton Publishing Company.) 9s. net.

The Geography of Disease. By Frank G. Clemow, M.D. (Clay.) 15s.

Country Rambles. By W. Percival Westell. (Drane.) 10s. 6d.

Experimental and Theoretical Course of Geometry. By A. T. Warren, M.A. (Oxford and Clarendon Press.) 2s.

Class Book of Botany. By G. P. Mudge, A.R.C.SC., F.Z.S., and Arthur J. Maslen, F.L.S. (Arnold.) 7s. 6d.

Twenty-eighth Annual Report of the Savilian Professor of Astronomy to the Visitors of the University Observatory for 1902-3.

Substances Minérales. By A. L. Herrera. (Mexico: Officina Tip. de la Secretaría de Fomento.)

Dream of Realms Beyond Us. By Adair Welcker. (San Francisco: 331, Pine Street.) 40s.

Conditions of Progress in Electro-Chemistry. By Joseph W. Richards, M.A. (Bethlehem, Pa., Lehigh University.)

Journal of the Anthropological Institute. July to December. 10s. net.

Theory of Observations. By T. K. Thiele. (C. & E. Layton.) 12s. net.

Municipalisation of Secondary Education. By J. W. Richards, B.A. (Simpkin.) 6d. net.

Results of Meteorological and Magnetical Observations. (Stonyhurst College Observatory.)

Plan for the Endowment of Astronomical Research. By E. C. Pickering. (Cambridge, Mass.: Astronomical Observatory of Harvard College.)

Boletin del Cuerpo de Ingenieros de Minas del Perú. No. 2. (Lima: Imp. Torres Aguirre, Unión 150.)

Essex County Council Technical Instruction Committee Report and Handbook. (Chelmsford: John Dutton.)

St. Kilda and its Birds. By J. Wiglesworth, M.D., F.R C.P, M.B.O.U. (Liverpool Biological Society.) 1s. 6d.

Voigtländer & Sohn: Catalogue of Photographic Cameras, Lenses, and Accessories.

Another View of Industrialism. By William Mitchell Bowack. (Unwin.) 6s. net.

THE MOVEMENTS OF THE MACKEREL.

By L. N. BADENOCH.

IT is remarkable how little is really known of the life-histories of the marine food fishes. In the case of every other large food industry much time and thought has been expended from earliest times upon the laws governing the existence and increase of the objects composing the supplies. But fish, until lately, we were content merely to capture, quite regardless of their birth and habits. Endeavours to obtain information from fisherfolk and others who are continually in contact with fish have not proved altogether satisfactory, and it was seen that, before the industry could be brought into line with other industries, the matter must be taken in hand in a systematic and comprehensive manner. With this aim in view special investigations for the purpose of elucidating the various problems presented are now being made on both sides of the Atlantic. None are more interesting than the series of researches into the natural history of the mackerel, which have been recently undertaken at the request of H.M. Treasury. This important species, with its movements, is one of the most difficult of all the commercial fishes to study or to comprehend.

Seeing it is a pelagic fish, and has a freely floating egg, one might be led, with some reason, to suppose that it would thereby be enabled to spend its whole life without approaching the land. Fortunately for man, every season, during the warmer portion of the year, it leaves the open sea and migrates towards the shore, when its presence becomes apparent through its surface distribution, the only period when it can be fished for. It frequents the coastal waters in the northern temperate region of the Atlantic. On the Atlantic coast of Europe it extends from Bergen, in Norway, southward to the Straits of Gibraltar; and throughout the Mediterranean it also occurs, being taken in large quantities on the coast of Spain, the south coast of France, the coasts of Corsica, and in the Adriatic. Round the British coasts, the four principal regions for the fisheries are the North Sea to Norfolk, the Channel, and the south and west coasts of Ireland.

Along with, and contemporaneous with the migration, is the massing together of individuals into the well-known so-called "schools," or shoals. In this way, they swim crowded together during, at any rate, a great part of the year, and the shoals often contain an immense number of fish. Those pertaining to any particular shoal are usually of about the same size. Schools of large fish and schools of small fish may be present in the same neighbourhood at the same time, but schools of different sized fish do not

appear to intermingle. Similarity in size has also been observed to be usual in the shoals of grey mullet. It is, in fact, not well ascertained whether these mackerel schools are formed by chance association, or are due to the selective association of fish, having some characteristic in common. Such evidence as is to hand in the case of other fishes, in that of the grey mullet, for instance, points to the conclusion that the principle of selective association plays a considerable part in the formation of shoals, and that similarity of size is one of the points selected.

As to the manner in which mackerel keep together in shoals little is known. Grey mullet probably follow each other by sight The shoal seems to have no definite leader, but follows any individual that makes a dart in a particular direction. At night they lie on the surface of the water, their heads not all pointing one way, as they generally do by day, and they do not move as a shoal. It may be doubted whether other shoal fishes, as pilchards, habitually travel about as a shoal at night. The iridescent colouring of many fishes may assist them in keeping together in shoals.

The migrations of these shoaling mackerel have long been a subject of speculation among naturalists, and though much is known that was formerly obscure, it is a subject, in its various aspects, that presents peculiar difficulties to arriving at certain or definite information. It is not long since the value of statistics showing the quantities of the fish landed at various ports at different times of the year has been recognised, and from these, English and foreign, a number of tables have been constructed which give an insight into the distribution of the mackerel on the coasts in question during the different months of the year. Of this seasonal distribution as a whole it may be premised that, while the same general systematic movements can be observed, considerable variation takes place from year to year as to the exact date of the appearance of the shoals in a particular locality.

During the first two months of the year few mackerel are taken in any locality, the cold period being presumably the time when the fish are farthest from the coast. The few caught are chiefly found in the western part of the English Channel—at a distance of thirty to forty miles out at sea, south of Start Point and south of Plymouth—off the south-west coast of Ireland, off the west of France, and in small numbers in the Gulf of Marseille. Often during the greater part of March the conditions of February do not materially alter. Throughout that month, and in April, the mackerel in the English Channel continue a long way off-shore, becoming, however, more abundant. Towards the end of March, or early in April, generally speaking, large schools approach the south-west coasts of Ireland and the west coast of France, and the great spring mackerel fishery commences. At about the same time mackerel fishing begins in the Mediterranean. In the eastern portion of the English Channel mackerel are not yet (April) taken in numbers, unless in exceptional years: at Dieppe some are taken in April.

The spring mackerel fishing reaches its height in May, and continues into June, becoming considerably less productive towards the end of that month. In the Mediterranean, on the west coast of France, on the south-west of Ireland, and in the western portion of the English Channel, during both May and June, the fish draw close inshore in great abundance, the fishing in all these districts attaining its maximum in May. In the eastern part of the English Channel, *e.g.*, St. Varley-sur-Somme, the fish are seldom plentiful before June; in the southern part of the North Sea a small fishery on the Danish coast begins in May; but at the English North Sea ports practically no mackerel are landed until June, and then they do not, in any measure, approach the numbers taken later in the year. Large shoals appear on the southern Norwegian coast, along the Swedish coast, and in the Kattegat, towards the end of May, and the principal fishery on these coasts is at its height in June.

At all the large fishing centres, as a general rule, a season of scarcity exists during July and August, between the great spring and autumn fisheries. Of this season on the south and west coasts of Ireland one of the inspectors says, there is a sharply-defined interval "between the two visitations of fish." It is true that at this time of the year mackerel in large numbers enter Plymouth Sound and inshore waters, where they are taken by whiffing lines and with the seine; but the mackerel appear to be scattered, and drift-net fishing is practically suspended. In Norway the summer fishing practically ceases about the middle of July. In the Mediterranean, at Cette, and at the majority of the ports, the great fishing is over in June, but to this Marseilles is an exception, the fish being generally plentiful until September.

September and October are the season of the great autumn fisheries. Immense schools visit the west coast of France and the south-west of Ireland, the quantities landed in some years equalling those of the spring fishery—a remark, perhaps, applying more strictly to Ireland. But as regards the west coast of England, practically an autumn fishery does not exist, and although on the south coast in most years the numbers landed increase in September as compared with August, they are by no means large, and show a decided falling off in October. After the beginning of September the mackerel leave Plymouth Sound, and are then caught in open water a few miles south of Eddystone Light, and south of Start Point. On the other hand, in the eastern part of the English Channel, and in the southern part of the North Sea—at the east ports of England and Gravelines—the most valuable fishery of the year is carried on at this time. During the last two months of the year, as during the first two months, mackerel fishing may be said to be closed on all the European coasts, though a few fish are still caught south of Start Point and the Eddystone, in the English Channel, and elsewhere.

The causes which bring about these periodic migrations are not by any means well understood. Study of the physical and biological conditions prevailing at different seasons of the year in the waters in which the shoals swim is being now undertaken, in order to throw light upon this important point. There can be little doubt that the temperature of the sea-water may be looked upon as one of the most important influences which determine—which may retard or accelerate—the movements of the fish; though some have supposed the influence to be an indirect one, by determining the presence or absence of the organisms which constitute the mackerel's food in the several localities. When the fish first visit the coast in spring and early summer it is chiefly in order to spawn, and, plainly, the demands made by the needs of the young are met by proximity to the land, where the smaller organisms of the plankton abound, besides all the numerous larval forms of the creatures whose home is the coastal waters. During the latter part of summer, and in the autumn, however, when the mackerel are in the inshore waters, small fish of other species become abundant, which then furnish the mackerel with a generous food supply. On their first coming to the coast to spawn they are not readily taken with bait, because at this period they take less food, especially the females, which for a time indeed cease to feed. Thus, we may roughly term the first migration the "spawning migration": the approach to the coast in the summer and autumn is a "feeding migration."

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Where do the mackerel go when they depart from the shore? Where are their winter quarters? One of the most generally accepted theories in the past, that they hibernate at the bottom of the sea in the neighbourhood of their summer haunts, was rightly condemned by some naturalists. Nor was an alternative suggestion, that they retreated to more southerly regions where they would find a favourable sea-temperature, and continued to live as during spring and autumn, near the surface, but in the open ocean, likely to be correct.

The conclusions that of late Mr. Garstang has come to profoundly modify the views which have hitherto prevailed concerning the extent of the migrations of this fish. He has clearly shown that the mackerel of the American and European coasts constitute two distinct varieties or races, possessed of differing characteristics, and also that there exist certain minor differences which appear to subdivide the mackerel frequenting the British coasts into two principal races, an Irish race, and those inhabiting the English Channel and North Sea.

This establishment of geographical or local races settles the dispute as to the length of the mackerel's migrations. The mackerel, Mr. Garstang points out, cannot cross the Atlantic; the pronounced difference exhibited between American and European fish proves that no mixture now takes place between the two races. Moreover, the difference revealed between the two principal British groups, the Irish and Channel fish, indicates that the mackerel of these regions do not travel far. Each race must have its own winter habitat, and this at no great distance from its summer haunts. In fact, the migrations, for the most part, resolve themselves into migrations from deeper to shallow layers of sea in the same localities. There is one exception, in the North Sea fish. The identity of the mackerel of the North Sea and English Channel—areas geographically contiguous—renders it certain that the theory is correct that the North Sea fish migrate from the English Channel in the spring, and return to it in the autumn. We have seen that while mackerel are in the western part of the Channel in March, few are taken in its eastern portion, or in the southern part of the North Sea before the end of May or in June. The important autumn fishery of these places, on the other hand, seems due to the movement of the fish on their journey back towards and through the English Channel. It may be that the early catches made off the south coast of England in December, January, and February, are the last of the autumn fish of the previous season moving down Channel on their emigration from the North Sea. That the first fish are caught to the eastward of Plymouth, subsequently travelling in a westward direction, to a few miles south-west of Eddystone Light, lends confirmation to this idea. This fact may also be considered in this connection, that in the Channel and North Sea the autumn fish appear to be slightly larger than the spring fish, and would seem to be the same fish at a more advanced stage of growth.

Doubtless the depth and extent to which the mackerel retire from the shore rests with the severity of the winter months. A series of expeditions for the purpose of investigating the seasonal changes of temperature and other conditions of the waters at the mouth of the English Channel have been lately accomplished, and the large quantity of material collected on the different voyages is receiving attention. If the expectations of the results of these observations be realised, a scientist will be able, having an adequately equipped vessel, to ascertain the most probable whereabouts of the schools of mackerel by his examination of the condition of the water at any given time. Such a result would revolutionize the state of the fishery industry, as from it would naturally follow the introduction of methods of fishing based on accurate scientific knowledge, in lieu of the unsatisfactory empirical ways still loved of fishermen in the present.

THE STRUGGLE FOR EXISTENCE IN SOCIOLOGY.

By J. COLLIER.

I.

IT may seem strange that two men of gentle disposition and benevolent character, like Darwin and Wallace, should have originated the conception of a universal, perpetual, and relentless warfare as being waged among all genera, all species, all varieties, and all individuals. They can have had little notion of the way it would be taken up, or the extravagant lengths to which it would be carried. German and French anthropologists have raised a pæan to war. The old wars between peoples will give place to far more destructive wars between races. The blonde, long-headed race that has hitherto led the advance of mankind dreads impending defeat at the hands of the dark, broad-headed races that have long been hewers of wood and drawers of water. All previous battles will have been a sport to the great battle of Armageddon that the new century may witness. "Men will be killed by the million," Herr Gumplowicz prophesies, "for one or two degrees more or less in the cephalic index." The French anthropologists take up the running, and play the game of Germany. The progress of humanity, M. de Lapouge announces in strident accents, requires the extinction, by force or famine, of the backward and pacific races. In the twentieth century "the last sentimentalists will look on at copious exterminations of peoples." The civilizations of Europe, if Dr. Gustave le Bon is right, will end, as they began, with social convulsions.

Our own savants are less sanguinary, but have equally perverted the science it was their business to expound. Mr. Herbert Spencer relates that in the early fifties, when he and Huxley (sometimes accompanied by Buckle) walked together on Sunday mornings, the rising naturalist as strenuously opposed as he afterwards supported the evolution of species. Unlike Spencer, he "did not allow his imagination to outrun the facts." He never became a true Darwinian. He thoroughly grasped the doctrine of development, and aided in establishing it on two distinct lines. But he never took kindly to the characteristic Darwinian hypothesis—the theory of natural selection. Very late in life, he did realise that other Darwinian conception of the struggle for existence, and this time he allowed his imagination to outrun the facts. In his last years, while his pugnacity discovered everywhere in nature traces of conflict, his hypochondria universalised the signs of consequent suffering. Others have imagined a pitiless series of pitched battles, or an incessant warfare as prevailing in the ancient world.

Not only are all such views exaggerations, as Wallace calls them; they disclose a total misapprehension of the facts. The words used to name these facts are in good part answerable for the perversion. An eminent Russian sociologist, Mr. James Novikoff, has written a book,* saturated with Darwinian conceptions rightly understood and generously applied, and yet pervaded by the same prepossession of an omnipresent battle. W. Roux and E. Metchnikoff describe the battle for existence between the different parts of the organism. *La lutte, der Kampf*, battle, war, and even "the struggle for existence" seem

* "La Lutte entre Sociétés humaines." Par J. Novicow. (Paris; Alcan, 1896.)

to err by diffusing over the whole the accidental complexion of a part. War in all its phases is a pathological phenomenon like a surgical operation, a collision at sea, or an explosion in a chemical works. Ninety-nine hundredths of the normal processes of nature are of a wholly different character. The myriad dance of the atoms, molecular cohesion, attraction of gravity, chemical affinity, biological assimilation, and sociological union are different forms of the same fact. War consists in the comparatively rare collisions that mark the passage to these ends; the real struggle consists in the effort made by individuals or societies to overcome obstacles, to put forth all their powers, to shape new products, to realise themselves. Conflict with others is a mere incident of the real battle. War is not the type of social effort; it is the action of society in a state of disease.

Its Characters.

Count Gaston de Saporta has described the gradual transformation of vegetal species in prehistoric Provence. A single or a few individuals of a new species or variety appear in a given area. They may be immigrants, or the variation may have arisen on the spot in consequence of some outward change. The new form proves to be better adapted than the old to the changed environment. A conflict ensues. Step by step the immigrant or variant advances to the conquest of the entire area. Foot by foot the species in possession of it resists. The battle (what we call battle) may stretch through thousands of years. There are no visible signs of struggle. The "fairy fineness of ear" that Arthur Hallam ascribed to young Tennyson would hear no cries. None the less, a great racial battle has been fought and, in the long run, a great victory won. The invaders have, to all appearance, driven out the indigenous species, which survives only in inaccessible or less-favoured spots.

A Danish naturalist has ascertained the tactics of the battle. The birch is in possession of a tract. Its branches are open and let down the sunshine to its base, where the beech strikes root in the humus formed by the decomposition of birch-leaves. The beech grows up, and, being longer-lived, it survives and prevails over the birch, whose seeds can effect no lodgment under the dense shadow of the beech. Only in sterile or sandy tracts, by lakes or in marshy soil, can the birch hold its ground.

We perceive in what the battle, the victory, and the defeat consist. No single birch perishes till its time is come, but it leaves fewer and fewer offspring, and it fattens the soil for its supplanter. No tree has been driven out of its habitat; those that survive in inhospitable spots have been there from the first. It is battle by elimination, victory by supplanting, defeat by disappearance.

The vegetal elimination thus described is the type of all substitution of one species for another. Animal species become mobile, add to these tactics the destruction of a rival or hostile species. To the animal methods man superadds systematic warfare and wholesale massacre. The additions affect only the degree and the rate. In vegetal, animal, human, and sociological species the process is at bottom identical. War, as we know it, is a mere incident, or at best an intenser form of the conflict. It is not its type.

The Ethnical Struggle.

The old ethnology described in detail the long series of migrations in mass from "somewhere in Asia" that peopled Europe. Even so sober a historian as Amédée Thierry assigns dates to these great racial movements with a precision that rivals the pre-Noachian chronology of Archbishop Usher. The new ethnology is satisfied that no such collective displacements ever occurred. All the probabilities, such historical evidence as we possess, and the analogies of our own day combine to suggest that human races have generally migrated as plants and animals have migrated. But instead of reasoning hypothetically, on data drawn from language and anthropology, about the early European migrations, let us take a contemporary example. Every step and incident of the colonisation of New Zealand can be traced; the process, indeed, can still be observed, and for grasping it in its reality direct observation is, in some form, almost essential.

The early explorers, who touched at the islands but did not remain, resemble the adventurous seeds and individuals that vegetal and animal species send out as scouts. The first immigrant to New Zealand was the first runaway sailor from one of the exploring ships. If John Rutherford, whose instructive narrative was incorporated by Professor Craik in his "New Zealanders" of 1830, was the first (as he is the first known) of this variety, then is he the progenitor of all existing white New Zealanders. He was soon followed by other adventurers. Runaway whalers, escaped convicts from Australia, beach-combers, wandering Jews, and sometimes a stray educated man like F. E. Maning, arrived one after another on a scene where wild men found themselves in a congenial element. Altogether, it was estimated that there were 150 *pakehas* scattered over the North Island before its annexation. Missionaries accompanied or followed them. A British Resident was appointed. The ways having been opened and the ground prepared by these forerunners, it was felt that the time had come for systematic colonisation. Another adventurer, the great colonising genius Edward Gibbon Wakefield, organized a series of semi-commercial, semi-philanthropic associations which in course of years despatched some thousands of colonists. Smaller groups from time to time founded special agricultural settlements. The local Government brought out shiploads of artizans and domestic servants. But there has been comparatively little emigration in mass. For the most part, it has taken place by individuals and families.

The resistance made by the natives to the early explorers was hostile, inspired by terror. When they got over their fright they received immigrants, the best and the worst, with impartial goodwill. Differences arose. War broke out; in the middle forties and the early sixties there was real war, waged by English generals, disciplined troops, and colonial auxiliaries. Though the two wars lasted for years and many battles were fought there was little destruction of life; perhaps a thousand Maoris at the most bit the dust. None the less, they have silently melted away "like snaw-wreaths in thaw," or like wax before a strong fire. From probably over 100,000 at the time of the British occupation of New Zealand, they sank in forty years to 40,000, and the decline steadily continues, in full peace, at the rate of one-eleventh in five years. As they have not been killed, neither have they been, on the whole, ill-used, two or three things have happened. They have mixed with the whites; 5000 half-castes are scattered through a population of 800,000, and in five years the number has increased by one-sixth. Next, ever fewer children are born. The large families of the old fighting days are no longer to be found. The natives themselves cannot account for the falling off; Darwin would ascribe it to the effect of the change of life on the most susceptible part of the system—the reproductive organs. The young die of consumption or other diseases induced by altered habits; drink has its hecatombs among the adults of both sexes. The older tribesmen die where they have always lived; the younger migrate. They cease to live by the side of the white man because they can no longer

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make a living. In Australia, as in the United States, the mere presence of the white man drives into the interior the big or small game on which the black or the red man subsisted. There was little such game in New Zealand, but the brown man could no longer deliver himself to his old pursuits. The white wanted his land, and paid him to leave it. From day to day the steadfast encroachment could be observed. Wanting money for ordinary purposes or for some special purpose (as the costly celebration of a chief's funeral), the natives part with their land bit by bit, and when the land goes (as they are well aware) the Maori goes with it. When once daylight and air are let in on the dark and, sometimes, stifling New Zealand bush by a beginning of tree-falling, the destruction of an entire forest is only a question of time. The fate of the forest is the fate of the brown race. Once it opens its ranks to admit even scattered members of a white race, its end may be retarded by bravery on its own part, or equity on the part of its conquerors, but its death is sure. In New Zealand, the last remnants will be found in the wild Uriwera country, whose fastnesses protect it against invasion.

The story is that of the birch and beech of Denmark. The methods of invasion, battle, and resistance are alike; alike, too, is the result. The earlier dark races have fattened the soil for the white invaders. They opened the bush, cut paths and cleared spaces, gave the grass time to grow, furnished servants, and often wives, to the immigrants, and sometimes fought on their side. Like Walt Whitman's redwood-trees, which rejoiced to be cut down for the use of man, they may congratulate themselves on being the forerunners of a greater race and thus aiding the advance of civilization. "The Government may take away my pension," said in 1884 a famous chief who had resolutely fought against the English twenty years before, "but it cannot take from me my loyalty to the Queen."

MICROSCOPY

Conducted by M. I. CROSS.

A POLARIZING VERTICAL ILLUMINATOR.

The interference tints produced by the polariscope in the examination of rocks and minerals enables the identification of constituents to be made by the petrologist. But in the thin sections which are commonly and necessarily prepared for the microscope, it frequently happens that the distinguishing colours are so faintly differentiated as to lead to confusion of identity, and although extraneous means are used for meeting the difficulties, even these do not yield distinctive results in all cases.

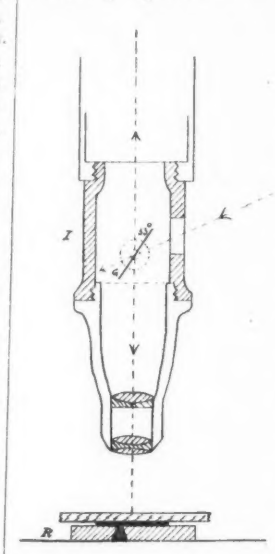
The new device of Professor Joly, described by him in the *Proceedings* of the Royal Dublin Society, is intended to aid observations to be made with increased accuracy.

The object under examination is laid upon a reflector of speculum metal (about 3 cm. diameter is sufficient), which is placed on the microscope stage, the thin cover of the specimen and not the slide being in contact with this reflector.

The illumination is effected with a vertical illuminator of the *disc* pattern, but with the aperture through which the light is admitted to the cover-glass disc reflector extended upwards to allow the illuminating beam to be directed upon the disc obliquely, so that the polarizing angle can be actually attained.

The accompanying diagram will make the matter clear. The illuminator is lettered "I," the cover glass for reflecting the light is shown at 33° with the vertical axis of the microscope, thus insuring that the light passing vertically through the object glass is at the polarizing angle (57° nearly) with the glass reflector.

Having adjusted the vertical illuminator disc so that the speculum reflector is illuminated, it will be observed that the reflected portion of the entering beam is plane polarized. Descending it passes through the slip carrying the rock section, then passing through the section it meets the speculum reflector "R" and is returned by it through the section and so back to the cover glass "C," the greater part of the beam passes upwards and reaches the eye; this is almost unmixed plane polarized light. A Nicol prism is, of course, used above the vertical illuminator.



It will at once be seen that the range of colour variation from one species to another will be greatly increased, the interference tints being the maxim proper to a plate of twice the actual thickness of the section in consequence of the passage of the polarized beam twice through the rock section.

Professor Joly further suggests that it will be found advantageous to perforate the reflector "R" with a small hole of conical shape, blackened inside so that when desired a small crystal can be examined simultaneously with the reflected ray and by light transmitted from the polarizer beneath the stage.

POND-LIFE COLLECTING FOR THE MICROSCOPE.

By CHARLES F. ROUSSELET, F.R.M.S.

THE fascinating study, under the microscope, of the living microscopic objects found in ponds, canals and lakes, collectively known as Pond-life, requires, first of all, that you should catch your game. The object of this note, therefore, is to discuss those methods of collecting which, with a good many years' experience, have proved to me the most practical, efficient and time-saving; it is intended for the young naturalist, or beginner, who desires to make the personal acquaintance of these minute atoms of life and thereby gain a better understanding of all living things.

Some few pieces of apparatus are indispensable, and these are the following:—

1. A Queketter's Collecting Stick with ring, net and bottle, and cutting hook.
2. A flat bottle.
3. A pocket magnifier.
4. A hand-bag with sundry wide-mouthed bottles.

THE COLLECTING STICK.—Can be obtained from most opticians; it is a hollow walking-stick with an inner rod to increase its length when required, and provided with a screw at the end for the attachment of either ring, net, dipping bottle or hook.

The ring is a stout brass hoop, about 6 in. in diameter. The net, which is sewn on to the ring, is made cone-shaped, about 6½ in. long, and at its apex is tied a small rimmed tube bottle of clear glass, about 3 in. long by 1 in. wide. The material of the net should be either fine muslin, known as "soft mull," with meshes fine enough to prevent the Infusoria and Rotifera going through and yet allowing the water to run out freely, or else a silk material known as "Swiss bolting silk," used by millers for sifting the various grades of flour, and obtainable from mill furnishers; No. 16 of this silk material has the required fineness.

The net is most important, and some care should be taken to have it properly made. Allowing a margin for the seam and for sewing round the ring, the shape and dimensions of the material for a 6 in. ring should be as represented in Fig. 1. This will give a net slightly larger than is required, but as the material is sure to shrink a little it will be of the right size after having been used once or twice.

The cutting-hook is a curved knife which can also be screwed on to the collecting stick, and is intended for cutting roots or water weeds which are otherwise out of reach.

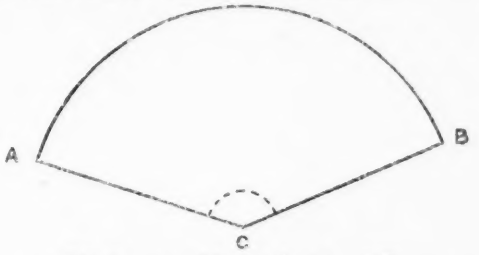


FIG. 1.—$a\ c = 9$ in.; angle at $c = 140°$.

THE FLAT BOTTLE.—Can now be obtained from the opticians, well made and cemented with fusible cement in the fire. When first invented by the late Mr. T. D. Hardy it was made by cutting a ⊔ shaped piece out of a thick flat piece of india-rubber or similar material, 4 to 5 in. long by 2 to 2½ in. wide, and ⅜ to ¾ in. thick; a square of thin plate glass of same size, cemented by means of Millers' caoutchouc cement on each side, completed the bottle. A thick piece of indiarubber is, however, so expensive that it is cheaper to buy the finished article. The flat bottle is used for searching over pondweeds with the pocket lens at the side of the pond, or examining the water which has been collected and condensed with the net. In round bottles it is very difficult to see minute animals clearly, whilst a thin flat bottle allows the whole contents to be readily scrutinized with a pocket lens of considerable power, and one can thus at once determine whether it is worth while to take home a sample from that particular pond for further examination under the microscope.

THE POCKET LENS best adapted for field work is Zeiss' improved aplanatic lens, magnifying 6 diameters, which has a very large flat field, long focus, and the most perfect definition all over the field.

The various groups of plants and animals commonly designated as Pond-life, which inhabit freshwater lakes, ponds and ditches, consist of Algæ, Desmids, Rhizopoda, Infusoria, Sponges, Hydræ, Rotifera, Polyzoa, Cladocera or Water-fleas, Copepods, Hydrachnida, Worms and Insect larvæ. All these can be divided for the purpose of collecting into two groups—the free-swimming, and those that are usually attached to water plants or submerged objects, and each of these groups must be captured in different ways.

All free-swimming or floating forms, which collectively are designated by the word "plankton," are best secured with the net. The net is passed through the water two or three or more times, and then held up; the water will run out in half a minute, and quite at the last the condensed animals will be seen entering the little bottle like a cloud, where they can be subjected to a preliminary examination. It is best, however, to empty the contents into the flat bottle, in which the examination with the pocket lens becomes very much easier, and most of the forms one is acquainted with can be recognized at a glance. In this way thousands of Algæ, Infusoria, Rotifera, Daphnia, &c., can be captured in a few minutes if the pond be a prolific one. Having thus ascertained that the dip contains some desirable forms, the water is poured into a larger wide-mouthed collecting bottle, of which three to six should be carried in the bag. These bottles should be numbered; for it is often advantageous to keep the water of different ponds separate, so as to be able to know at home from which pond a particular creature has come. Ponds vary exceedingly as regards their contents in Pond-life; a small pond may be very prolific, whilst another, possibly a larger piece of water only a few yards off, may contain hardly anything worth collecting. By trying all the different ponds, small and large, within reach of an afternoon's walk, one usually succeeds in obtaining a good gathering of free-swimming forms. The net quickly condenses a large volume of water, so that few species, even if present in small numbers only, will escape being captured. Several other methods of condensing pond water have been devised, but the collecting net with bottle attached is so simple and effective that we need not trouble about any other apparatus. It may be advisable to try the larger ponds in various places, and both near the surface and also in deep water, as some plankton forms may have collected in one particular corner of the pond and be absent elsewhere; this is often the case with *Volvox globator*. The use of a boat on larger lakes is very desirable when available. For Rotifers and other active free-swimmers it is not advisable to disturb the mud at the bottom of the pond, but certain species of Cladocera, Hydrachnida, and insect larvæ can only be found at or near the bottom.

(*To be continued.*)

PRACTICAL SCHEME.—Through the kindness of Mr. J. T. Neeve, of 4, Sydenham Road, Deal, I am able to offer for distribution four named varieties of Marine Algæ, mounted on paper, which can be kept either as herbarium specimens, or can be mounted as microscopic objects, for which latter they should be soaked in soft or rain water for twenty-four hours, which will cause the specimens to assume their natural state. Then mount in Dean's medium or glycerine jelly. If mounted in balsam in the dried state the cells are distorted and shortened. The instructions given for the mounting of Fungi, a few weeks ago, are also recommended by Mr. Neeve.

Applicants for these Marine Algæ are requested to enclose with the Coupon appearing in the advertisement pages of this number, a stamped, directed, square envelope, about 5 in. by 4 in. Particular attention is drawn to this point as it considerably reduces the amount of labour involved in this distribution.

Should any readers of this journal wish for further specimens, I should recommend them to apply direct to Mr. Neeve, at the address given above, who is both an authority and an enthusiast in this particular work.

NOTES AND QUERIES.

Lt. Damant.—The following would be the best manner for cutting sections of Marine Worms, to show the arrangement of parts:—Pin the worm, slightly on the stretch, on a strip of wood and harden in methylated spirit for ten days, changing the spirit every day for the first three days. Then cut the specimen up into pieces about ¼ in. long, place these in absolute alcohol and transfer to equal parts of absolute alcohol and ether and soak for about twelve hours. Place in a thin solution of celloidin for about twelve hours, transfer to a thicker solution of celloidin for twelve hours. Remove from celloidin on the point of a needle and expose to the action of the air until the celloidin drys, then push off with a needle into methylated spirit and soak for twelve hours to complete hardening of the celloidin. Place the infiltrated portion of worm between two pieces of carrot, fit it to the embedding arrangement of the Catheart Microtome and make the sections. Stain in Grenacher's carmine, wash out excess of stain in methylated spirit acidulated with hydrochloric acid, one part acid and six of spirit. Then wash well in methylated spirit and place in absolute alcohol for two or three minutes, no longer, clear in oil of origanum and mount in Canada balsam. If preferable, the pieces of worm may be stained in bulk in carmine before they are infiltrated with celloidin. Permanganate of potash is used for decolourising sections when overstained with carmine, but the acidulated spirit answers quite as well and gives less trouble.

W. S. Rogers.—The most likely way to remove the siliceous matter is to boil the material in a weak solution of bi-carbonate of soda. If this is not successful the only alternative is to select the specimens from the *debris* by hand.

Pinacoid.—The only two makers of binocular dissecting stands of such low power as you require are Zeiss and Leitz, but it seems doubtful to me if either of them will exactly meet your conditions as to portability. The majority of such instruments are fitted with prisms at the eyepiece end, and have two tubes which are inclined at an angle one to the other, and necessitate the use of two objectives. Leitz's binocular preparation microscope, consisting of two Brücke lenses magnifying four diameters, only costing £3, can be taken to pieces for packing, and is of considerable value for preparation purposes. I think you would be better suited with an ordinary single lens dissecting microscope. Any London house would send you lists or particulars of Leitz or Zeiss microscopes.

W. S. Baxter.—I am sorry it is impossible to accede to your request; there are many simple explanations of Numerical Aperture given in various works on the microscope, the perusal of which will give you the desired information.

XUM

A. G. Watkins.—The only satisfactory way to test the magnification of a lens is to project the lines of a stage micrometer on a screen at, say, 30 in. distance from the back lens of the objective, measure the separation of lines so projected, and divide by three.

Seco.—The photographs that you send are exceedingly good, and you have every reason to be satisfied. The names of the specimens you wish identified are as follow:—(1) Species of Surirella; (2 & 4) Anchors and Plates of Synapta; (3) *Actinocyclus ralfsii;* (5 & 6) Wheel plates of *Chirodota violacea;* (7 & 8) *Heliopelta metii.* The centre specimen is a Radiate plate from *Myriotrochus rinkii.*

Communications and enquiries on Microscopical matters are cordially invited, and should be addressed to M. I. CROSS, KNOWLEDGE *Office,* 326, *High Holborn, W.C.*

NOTES ON COMETS AND METEORS.

By W. F. DENNING, F.R.A.S.

PRESENT COMETS.—There is no tolerably conspicuous comet now visible in the region north of the equator. Giacobini's (1903 A) is traversing the southern hemisphere, and at the beginning of June will be moving to N.W. in Octans, and in a position about six degrees from the S. pole of the heavens. Southern observers will probably have had a good view of this object during April. Early in that month it was about 80 times as bright as when first discovered, but its proximity to the sun at the period named must have prevented its being seen. On April 15th, however, it was 45° S. of the sun, and a rather striking and conveniently observable object from southern latitudes.

GIACOBINI'S COMET (1902 B) passed very closely N. of α Geminorum (Castor) at the end of April, but was too faint for ordinary instruments. The increasing distance of this remote object, situated, as it will be, in the strong twilight of a June sky, will render it quite invisible.

GIACOBINI'S COMET (1896 V.).—This faint comet, for which Prof. Hussey computed a period of 6½ years, is due at perihelion on about June 22nd, and the conditions make it probable that it may be re-detected and followed during the ensuing summer and autumn. The predicted positions of the comet are given in an ephemeris by Ebelli of Kiel, for Berlin mean midnight:—

Date 1903.	R.A. h.	m.	s.	Dec. °	′	Distance from Earth in Millions of Miles.	Computed Brightness.
June 2 ...	23	50	47	+ 8	58	136	1·96
„ 6 ...	0	2	50	+ 10	1	134	2·03
„ 10 ...	0	14	52	+ 11	1	133	2·10
„ 14 ...	0	26	53	+ 11	58	131	2·17
„ 18 ...	0	38	51	+ 12	53	129	2·23
„ 22 ...	0	50	47	+ 13	45	127	2·29
July 24 ...	2	20	51	+ 18	17	116	2·60
Aug. 25 ...	3	30	50	+ 18	19	106	2·70
Sep. 26 ...	4	4	43	+ 14	12	97	2·66
Oct. 28 ...	3	54	51	+ 8	6	96	2·21
Nov. 29 ...	3	25	58	+ 4	6	114	1·26

Thus, at the opening of June, the object passes 4 degrees S. of γ Pegasi (mag. 3), enters Aries in July, and Taurus in August, while it will be placed immediately W. of the Hyades in September, thereafter moving very slowly to S.W. The unit of brightness in above ephemeris corresponds with that exhibited by the comet when last seen on 1897, January 4. As the date of perihelion is not accurately known, it will be advisible, when sweeping for the comet, to examine the region lying several degrees E. and W. of the positions given in the ephemeris.

THE APRIL METEORS.—At the period of the recent return of the Lyrids the weather was extremely cold and winterly, with severe frosts and hazy skies at night. Temperature offered a singular contrast to that experienced ten years ago, when summer heat prevailed, the maximum shade readings of a thermometer at Bristol being 1893, April 19, 75°; April 20, 77°; April 21, 81°; and April 22, 78°. The April meteors of 1903 were, perhaps, regarded with more than usual interest from the circumstance that just 100 years ago (viz., on the morning of 1803, April 20) a brilliant and abundant display of these objects was observed in America. There was, however, no visible repetition of that grand spectacle in the present year, for on the morning of April 20 the writer, at Bristol, watched a sky that seemed very still; meteors only came at long intervals, while the Lyrids were almost entirely wanting. At 1h. 40m. a.m., however, a sudden wave of light caused the observer to look towards N.W., when a very brilliant meteor was seen descending slowly from β Ursæ Majoris to β Camelopardi. In traversing a path of 39 degrees, it occupied 4½ seconds, and left a thick train of yellow sparks in the immediate wake of its nucleus. Radiant probably at 218°−31° (about 8° S.W. of 20 Libræ, mag. 3·3), from which point a well-pronounced shower of slow meteors was directed at the Lyrid epoch in 1900. This fireball may be said to have fittingly commemorated the centenary of the brilliant display witnessed in 1803. The April meteors generally appear to have presented no special activity or interesting features this year, but they were pretty well observed, and it is hoped to refer to some of the results next month.

LARGE METEORS.—April 11, 11h. 56m. G.M.T.—Fireball brighter than Jupiter observed at Lisburn, Ireland, by Mr. John McHarg. Flight directed from β Herculis, or possibly a little higher up, and ended near β Cygni.

April 19, 10h. 6m.—Fine meteor = ♀, observed by Prof. A. S. Herschel, at Slough. Path, 217° + 16° to 249° + 35°, and probable radiant at about 172° − 22°. Duration, 3½ seconds. It left a short tail of red flakes.

April 21, 13h. 11m.—Large meteor, 3 × ♀, recorded by Prof. A. S. Herschel, at Slough, with a path very swiftly traversed from 131½° + 40° to 126½° + 34°. It gave a transient yellow flash, and was directed from the usual radiant of the April Lyrids.

April 22, 10h. 29m.—Meteor = ♀, seen by Mr. C. L. Brook, at Meltham, near Huddersfield. Path, 308° + 43° to 345° + 40°. Duration, 3½ seconds. Colour, pale bluish-green. Observed also by Mr. G. W. Middleton, at Mexborough, who says the northern sky was lit up as by a flash of lightning. The fireball seemed to explode at about 8 Cephei, and to have been directed from near α Cephei. After falling 6° or 7° it burst out again with a beautiful greenish light, and expanded into a sort of nebulous halo.

April 22, 10h. 36m.—Meteor = ♃, recorded by Mr. T. H. Astbury, at Wallingford, shooting from 203° + 75° to 146° + 68° in 1¾ sec. It was a fine Lyrid, leaving a brilliant white streak. This meteor was also registered by Prof. A. S. Herschel, and adopting a radiant at 271° + 34° from the combined paths, the heights appear to have been from 70 to 56 miles over Northamptonshire.

THE FACE OF THE SKY FOR JUNE.

By W. SHACKLETON, F.R.A.S.

THE SUN.—On the 1st the sun rises at 3.52 and sets at 8.3; on the 30th he rises at 3.48 and sets at 8.18.

Summer commences at 3 P.M. on the 22nd, when the sun enters Cancer; this is also the longest day, its duration being 16h. 33m.

Sunspots are now of frequent occurrence, and of late the solar disc has scarcely been devoid of spots.

THE MOON:—

	Phases.	H. M.
June 2	☽ First Quarter	1 24 P.M.
„ 10	○ Full Moon	3 8 A.M.
„ 18	☾ Last Quarter	6 44 A.M.
„ 25	● New Moon	6 11 A.M.

The moon is is apogee on the 13th, and in perigee on the 26th.

Occultations:—

Date.	Star Name.	Magnitude.	Disappearance. Mean Time.	Angle from N. Point.	Angle from Vertex.	Reappearance. Mean Time.	Angle from N. Point.	Angle from Vertex.	Moon's Age.
			h. m.	°	°	h. m.	°	°	d. h.
June 2	p^3 Leonis	6·2	9 44 P.M.	157	104	10 43 P.M.	267	231	6 23
„ 4	B.A.C. 4294	6·1	8 14 P.M.	134	131	9 27 P.M.	274	258	8 22
„ 8	ζ^1 Librae	6·0	1 23 A.M.	144	117	2 14 A.M.	233	201	12 3
„ 27	69 Cancri	5·7	8 42 P.M.	159	119	9 14 P.M.	234	196	2 15

THE PLANETS.—Mercury is unobservable during the former part of the month, since he is in inferior conjunction with the sun on the 3rd. Towards the end of the month he is a morning star in Taurus, not far from Aldebaran, and is at greatest western elongation of 22° 5′

W. on the 28th, when he rises about $1\frac{1}{4}$ hours before the sun; the bright morning twilight will, however, interfere with easy observation.

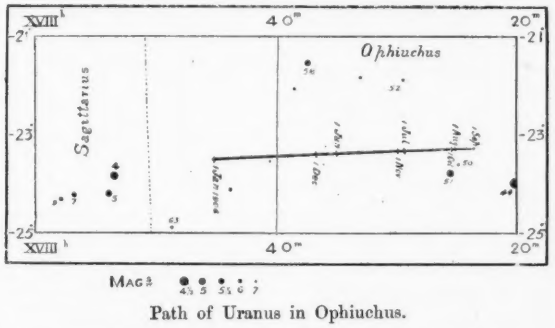
Venus continues to be the most conspicuous object in the evening sky looking rather north of west. The planet is increasing in brilliancy, and is so bright that it can easily be picked up in twilight, and observation may be continued until quite late, as she does not set until 11 P.M. The best time for observing is, however, soon after sunset, while it is still moderately light, as then the disc appears more sharply defined, and any outstanding colour of the telescope is less obtrusive. About the middle of the month the planet is on the meridian at 3.9 P.M., having an altitude of 59°; a little searching with a pair of field-glasses should enable one to detect this bright object in broad daylight. The diameter of the planet increases from 16″·6 at the beginning of the month to 21″·6 at the end. Near the middle of the month, 0·61 of the disc is illuminated, or the planet exhibits a phase similar to the half moon. On the 28th Venus is near the moon, and on the 23rd near the 6th magnitude star 83 Cancri.

Mars is still available for observation throughout the month until near midnight, setting on the 1st at 1.35 A.M., and on the 30th at 11.49 P.M. The planet is diminishing in brightness, also the diameter decreases from 10″·4 at the beginning of the month to 8″·4 at the end. The disc presents a gibbous appearance, 0·89 being illuminated. The latitude of the centre is +25°, so that the north polar cap is presented to us, and therefore the snow cap appears at the bottom in the ordinary inverting telescope. The planet is describing a direct or easterly path in Virgo in the direction of Spica; he is near the moon on the morning of the 4th.

Jupiter is in Aquarius, but does not rise before midnight until near the end of the month.

Saturn is in Capricornus, rising about 11.30 P.M. near the middle of the month, but on account of his great southerly declination he is not well placed for observation.

Uranus is on the confines of Ophiuchus and Sagittarius, and is in opposition on the 15th; the extreme southerly declination of the planet is such that he only attains the altitude of the mid-winter sun. The accompanying chart will enable the planet to be found, when it appears as a star of about the 6th magnitude, and can be seen occasionally with the naked eye, but readily with slight optical aid.



Path of Uranus in Ophiuchus.

Neptune is no longer available for observation, being in conjunction with the sun on the 26th.

THE STARS.—Position of the stars about 10 P.M.:—

ZENITH . Great Bear, Cor Caroli.
NORTH . Ursa Minor, Cepheus, Cassiopeia.
EAST . Cygnus, Lyra, Aquila, Sagittarius.
SOUTH . Hercules, Ophiuchus, Corona, Libra, Scorpio.
WEST . Leo, Cancer.—S.W.: Virgo and Bootis.—N.W.: Capella.

Chess Column.

By C. D. LOCOCK, B.A.

Communications for this column should be addressed to C. D. LOCOCK, Netherfield, Camberley, and be posted by the 10th of each month.

Solutions of May Problems.

No. 1.—(W. Geary).
1. P to Q4, and mates next move.

No. 2.—(T. Geary).
Key-move—1. K to Qsq.
1. . . . K to K5, 2. Q to Q3ch.

SOLUTIONS received from "Alpha," 2, 4; W. Nash, 2, 4; G. A. Forde (Major), 2, 4; "Looker-on," 2, 4; A. H. H. (Croydon), 2, 4; W. H. S. M., 2, 0; G. W. Middleton, 2, 4; J. W. Dixon, 2, 4; C. Johnston, 2, 4; H. S. Brandreth, 2, 4; H. F. Culmer, 2, 4; T. Dale, 2, 4; A. C. Challenger, 2, 4; W. J. Lawson, 2, 0; H. H. Bowdler, 0, 0; J. L. McLaren, 2, 4.

J. C. Candy.—Thanks for the problem.

J. W. Dixon.—Thanks for your appreciation.

A. C. Challenger and F. H. Worsley-Benison.—Solutions last month too late to acknowledge.

E. A. Servante.—Thanks for the problems. The three-mover cannot be used in a solution tourney as it has appeared before. The others will be printed ultimately if found up to the mark, but will have, I fear, to wait some time.

W. J. Lawson.—Is not 1. . . . K to K5 a sufficient answer to 1. Kt to Q4?

W. H. S. M.—You appear to have overlooked that after 1. Kt to Kt7 the King has an available square at QB4.

Hamilton White.—I can only suggest that you should send the end-game elsewhere. You are in error in supposing that the solution was "not obvious" to me. But I imagined the solution I found to be a "cook," and asked accordingly for the author's solution.

W. S. Branch.—Many thanks for your letters and cuttings. I maintain the silence which you request as to the other matter.

Mrs. W. J. Baird.—Many thanks; I give it in this number.

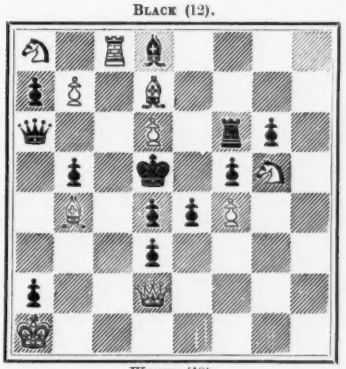
W. Nash.—I fancy that I have seen it before. Nevertheless it is very pretty and instructive, and may be new to most of our readers.

PROBLEMS.

By J. C. Candy.

No. 1.

BLACK (12).

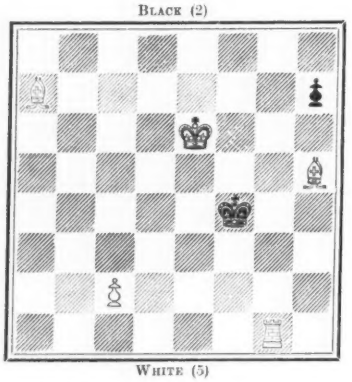


WHITE (10).

White mates in two moves.

No. 2.

BLACK (2)



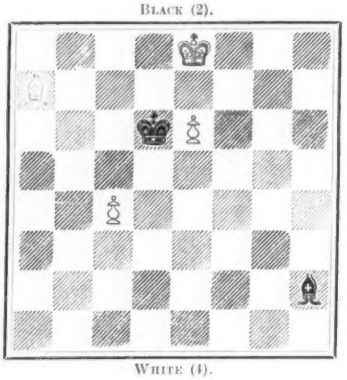
WHITE (5)

White mates in three moves.

CONDITIONAL PROBLEM.

By Mrs. W. J. Baird.

BLACK (2).



WHITE (4).

White retracts the move which he has just made, and plays another instead. Then Black plays so that White can mate on the move.

[This will, of course, not count in the Solution Tourney.]

Mr. W. Nash sends the following pretty end-game which is probably to be found in some standard work:—*White*, K at KKt8, R at K2, Pawns at KKt6 and 7; *Black*, K at Q2, R at KR8. White to play and win. The solution is 1. R to K6. If then 1. . . K × R, 2. K to B8, etc. Or if 1. . . R to KB8, 2. R to KB6, etc.

No objection having been lodged against the award in the KNOWLEDGE Problem Tourney, that award now becomes final, and the prizes will be sent to Messrs. Heathcote, W. Geary, and Lane forthwith

CHESS INTELLIGENCE.

Mr. F. J. Marshall, while in London, won a short match against Mr. J. Mortimer by four games to love. At the time of writing, Mr. Marshall is leading in the "King's Gambit" Tourney at Vienna.

The "brilliancy" prizes in the Monte Carlo Tournament have been awarded to Herr Mieses and Mr. Pillsbury.

The game below, from the International Cable Match, is remarkable for the combination, beginning at the 25th move, by which Mr. Marshall turned the tables on his opponent. Mr. Atkins could nevertheless have drawn by 25. . . R × Kt; 26. R × R, B × R; 27. R × B, Q × R; 28. Q to K7, R to Bsq., when White would draw by perpetual check.

Queen's Gambit Declined.

WHITE. F. J. Marshall.	BLACK. H. E. Atkins.
1. P to Q4	1. P to Q4
2. P to QB4	2. P to QB3
3. Kt to QB3	3. Kt to B3
4. P × P	4. P × P
5. B to B4	5. Kt to B3
6 P to K3	6. P to K3
7. B to Q3	7. B to K2
8. Kt to B3	8. Castles
9. Kt to K5	9. Kt × Kt
10. P × Kt	10 Kt to Q2
11. Q to B2	11. P to KKt3
12. P to KR4	12. Kt to B4
13. P to R5	13. Kt × Bch
14. Q × Kt	14. P to KKt4
15. P to Kt3	15. P to B4
16. P × P e.p.	16. B × P
17. R to Qsq	17. Q to Kt3
18. R to Q2	18. R to Q2
19. Castles	19. QR to Bsq
20. R to Bsq	20. B to Kt4
21. Q to B2	21. R to B5
22. Q to Kt3	22 Q to B3
23. R (Q2) to B2	23. R to Bsq
24. Q to R3	24. B to R3
25. P to Kt3	25. R to B4
26. Kt × P	26. R × R
27. R × R	27. Q × R
28. Kt × Bch	28. K to B2
29. Q to Q6	29. K × Kt
30. B to K5ch	30. K to B4
31. P to B3	Resigns.

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